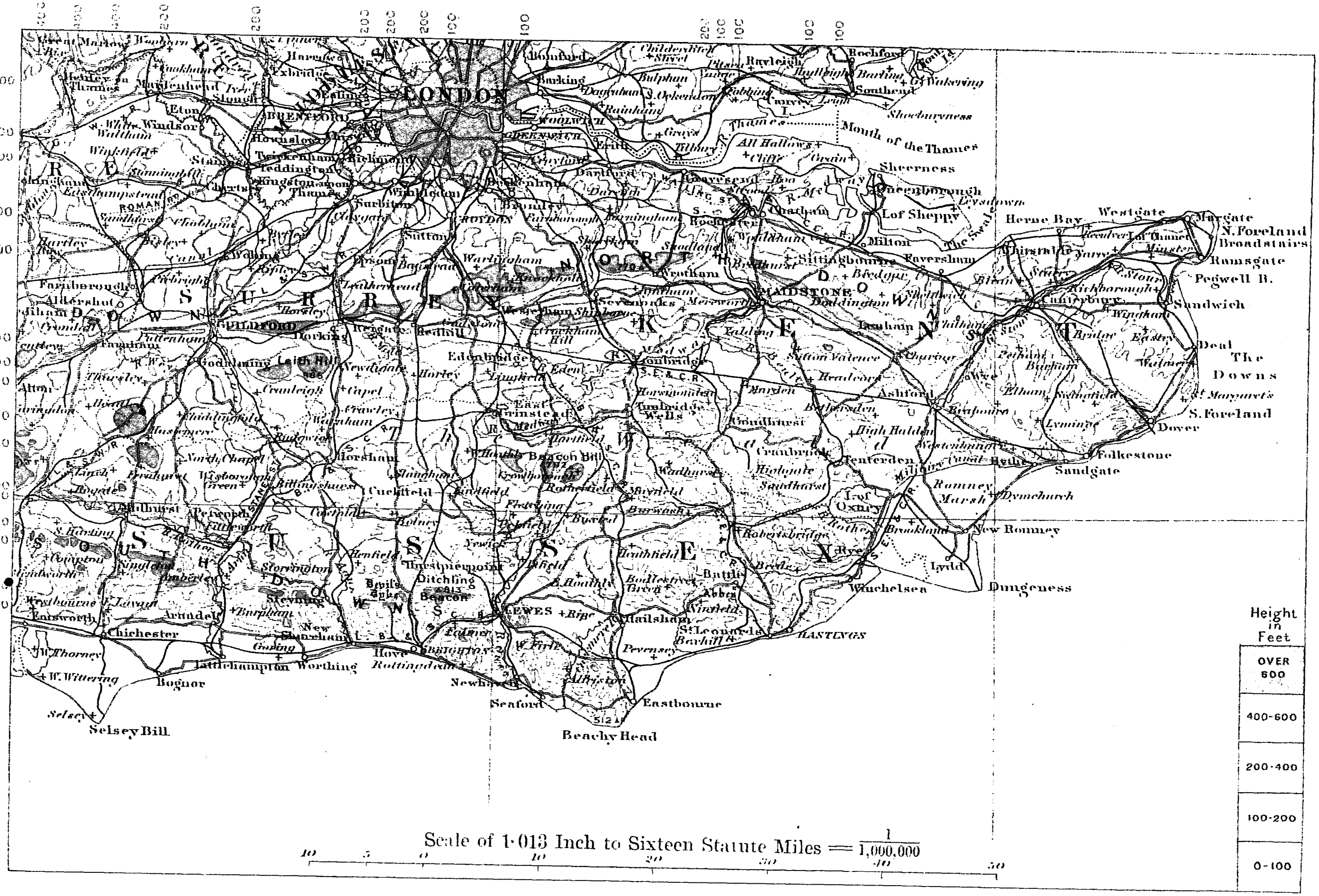

Fig. 1. OROGRAPHICAL MAP OF THE SOUTH EAST COUNTIES, ENGLAND.

BOARD OF AGRICULTURE AND FISHERIES.

A REPORT

ON THE

AGRICULTURE AND SOILS

OF

KENT, SURREY, AND SUSSEX,

BY

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INTRODUCTION.

The survey of the soils and agriculture of the three south-eastern counties, now published, was begun by the writer in 1899, when Principal of the South-Eastern Agricultural College at Wye, and was then intended as a survey of the soils of Kent and Surrey only. The County Councils of Kent and Surrey agreed to defray the cost of a special assistant working at Wye; Mr. F. J. Plymen, A.C.G.I., was appointed and carried out the earlier analysis contained in a first report dealing with the soils of the Chalk, the London Clay, and the Gault, which was published in 1902. On my removal to Rothamsted, Mr. Plymen continued the analyses, until in 1906 he was appointed to a Professorship in India, whereupon Mr. Arthur Amos, B.A., took up the work at Wye. Mr. Amos left Wye before he had time to complete many analyses, though he collected a large number of the later samples. When in 1907 Dr. Russell joined the staff of the Rothamsted Experimental Station, we determined to complete the work, which otherwise seemed in danger of lapsing, and the remainder of the analyses have been carried out in the Rothamsted Laboratory. We decided to add Sussex to the area under investigation, and to push our enquiries further so as to include a general account of the agriculture of the well-defined natural district we were then dealing with. It was also necessary to repeat all the mechanical analyses previously made at Wye, because the method now followed differs in several details from that adopted in the earlier work: in consequence, the figures that follow do not coincide with those given in the first report above cited. The chemical analyses were repeated in most cases, indeed, nearly all the figures now given have been obtained in the Rothamsted Laboratory. For these later analyses Mr. H. J. Vipond, B.A., was retained until his departure to the Transvaal Department of Agriculture, whereupon Mr. F. N. Carter, late of Wye College, and Mr. A. V. Campbell took up the work. Practically all the mechanical analyses have been made by Mr. A. Oggelsby, of the Rothamsted Laboratory; the staff of which have also carried out other miscellaneous determinations.

For the account of the agriculture of the three counties we have had to draw material from many sources; from our residence at the Wye College we have been brought into close contact with the farming of Kent and Surrey, and we have since made many special journeys through the whole district in order to collect soil samples and obtain information. But our personal experience could have supplied but a fraction of the material that was required, had we not received most liberal and generous help from farmers and others interested in the agriculture throughout the district. Circulars of enquiry regarding rotations, varieties of crops, grain, &c., were widely distributed, and were generally returned with much valuable supplementary information attached to them. Another circular, addressed to the agents of the great estates, brought us much indispensable information as to the

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woodlands in the three counties. To the large number of gentlemen who have helped us, either by taking soil samples on their land or by giving us information, we would wish to tender our warmest thanks, but there are among them several who have on many occasions given us so freely of their time and attention that we may be allowed to mention them by name. Mr. Arthur Finn, of Lydd, has been constant in his assistance to our work in Romney Marsh; Mr. Henry Rigden, of Ashford, has always allowed us to draw on him for information about Kent sheep and Sussex cattle; and Mr. W. H. Hammond, of Canterbury, has also helped us in many ways. Mr. Charles Stokes, of Ashford, has prepared for us the map of Romney Marsh, in which he has incorporated the results of his long studies of the changing coast line. To these names should be added those of Messrs. Alfred Amos, of Wye; H. W. Clements, of Boughton Aluph; M. Fayers, of Holmwood; H. W. Drewitt, of Colworth; W. Killick, of Beddingham; and S. Eames, of Lynch, Midhurst; while among our old colleagues and pupils, K. J. J. Mackenzie, Arthur Amos, C. T. Gimingham, and G. H. Grellier have been particularly useful. For the photographs we have been, among others, indebted to Dr. G. Abbot, of Tunbridge Wells; Dr. F. V. Darbishire, of Wye College; and to A. H. De 'Ath, of Ashford, who took great pains over the views he was asked to obtain for us.

The maps, which show the distribution of crops, are based upon the parish returns, of which the Board of Agriculture were good enough to supply us an abstract.

Finally, we have to thank the Board of Agriculture for undertaking the publication of the whole report. When we had reached the end of our work and began to consider the question of publication, it was apparent that no publisher could bring out the book with its numerous maps and illustrations and its mass of figures, except at a price which would put it out of reach of the farmer. Yet the whole work had been done for the benefit of the working farmer; we, therefore laid the matter before the Board of Agriculture, who obtained the permission of the Treasury to bring out the book in its present form and price, in order to render it widely accessible.

It will be seen that we have taken the geological formations as the basis of our work, and have assumed that each formation represented in the district will give rise to a soil type which can be characterised both by its mechanical analysis and by special features in the farming which prevails over its outcrop. The justification for these cardinal assumptions was obtained in the early stages of the work by following the dividing line representing the outcrop of two formations, and finding (1) that the dividing line held for the soils as well as for the underlying formations; (2) that the soils from any formation (with one or two exceptions) did show on analysis certain common features which marked them off from other soils. These conclusions have been strengthened as our work proceeded; all our experience in the field goes to show that each formation in the area under consideration gives rise to a distinct soil type, the characteristic composition of which can further be recognised by making up

an average from the mechanical analyses of the samples taken from that formation. Even in such a case as that afforded by the Lower Wealden soils, which vary from something near a sand to a heavy clay, there still exists but one type of soil, possessing very marked and special characters though subject to a considerable range of variation from light to heavy. The evidence also goes to show that the method of mechanical analysis adopted does determine the fundamental structure of the soils, and that fair agreement may be expected between the composition of samples taken in a particular area. For instance, samples 290—4 were obtained at various levels in two fields not far apart, and the uniformity they show (p. 183) is sound evidence of the validity of the methods adopted and the comparative smallness of the experimental error. We have been favoured by the absence of any widespread drift formations like the "boulder clay," the "drifts" with which we have had to deal are, as a rule, of small extent, and give rise to distinctive soils. Of course, local drifts are always in evidence where the slopes are as steep as they are over much of the south-east of England; the soil is in continual motion downhill, and we see many examples of the modification of a soil by washing from above, and of the proximity of the raw sub-soil on the heights because the surface soil has been largely carried below. Our work, then, is based upon the "drift maps" of the Geological Survey, and any farmer who wishes to obtain information as to the composition of his soils, the appropriate manures, seed mixtures, &c., must locate his farm on the one-inch to the mile map of the Geological Survey, drift edition. This will inform him of the formation to which his soil belongs, and a corresponding heading will be found in the book. Certain difficulties are, however, likely to arise in the use of this map; the survey of the drift of this district is an old one, it was only made on the one-inch scale, and is not free from errors; moreover, as published, it is laid down on a map surveyed in 1804. Thus we have only a century-old map on which to identify fields, and this for a district which has become so altered in character as these three counties within touch of London. Commons have been enclosed, woods have been felled, roads have been straightened since the map was made, so that in many places it has become more than difficult to identify the position on the map of a particular field or farm.

The authors would, finally, wish to express their sense of the slightness and incompleteness of their work; it is only a sketch and not a finished survey. They would have wished to obtain at least ten times as many samples, and to investigate in detail many questions which they have had to ignore; the amount of time that would have been required was, however, too great for men who were primarily occupied with other work. They hope, however, that this preliminary sketch may demonstrate the possibility of a soil survey useful to the farmer, and indicate the lines on which it can be fruitfully carried out.

A. D. Hall.

TABLE OF CONTENTS.

LIST OF ILLUSTRATIONS.

A REPORT

ON THE

AGRICULTURE AND SOILS OF KENT, SURREY, AND SUSSEX.

CHAPTER I.

Natural Features of the District.

The Counties of Kent, Surrey, and Sussex constitute one of the most clearly defined natural areas in Great Britain, marked by certain striking physical features common to the three counties and not extending sensibly beyond their borders. These features, together with the soils and the systems of agriculture prevailing, are the outcome of the special geological structure of the area. The district under survey is about 100 miles long and 50 miles broad; its western boundary is formed by the great central knot of the chalk formation which constitutes the larger part of Hampshire, the river Thames forms the northern boundary, while south and east comes the sea. From the chalk mass at the west two arms project eastwards into the area, one forming the South Downs and terminating at Beachy Head, the other forming the longer range of North Downs and terminating in the chalk headlands between the North and South Forelands. These chalk ranges with the Wealden area, lying as it were half enclosed by their arms, form the district under consideration, and though the Weald does run a little distance into Hampshire at its narrow starting point, practically the whole Wealden country, together with the North and South Downs which form its rim, are included within the three counties of Kent, Surrey, and Sussex.

Physiography.—To understand the structure of the country reference must be made to the two maps showing the geology (Fig. 56) and the level of the land (Fig. 1) respectively; it will then be seen that the core of the area is a stretch of high land extending from near Horsham to Tunbridge Wells and on to the sea by Hastings. This region of sands and clays, which reaches its highest point (803 feet) at Crowborough Beacon and is deeply scored by numerous streams, forms the High Weald; it is surrounded on all sides except the sea by a much lower flat area of clay land forming the Wealden plain. Geologically it is important to notice that the strata of the High Weald dip to the north on the northern side and to the south on the southern side, so that they pass under the clay of the Wealden plain, which geologically speaking is higher in the series and the more recent formation. Forming a rim

round the whole Wealden plain comes a series of sandy rocks, which in many parts rises to a considerable height (967 feet at Leith Hill) and presents a steep scarped face to the Weald Clay, which is both geologically and physically below it. This Lower Greensand series occupies a greater area and rises to higher levels on the northern side of the area; from Haslemere to Leith Hill in Surrey it forms extensive tracts of poor moorland, but little in cultivation. Steeply scarped as it faces the Weald the other slope is more gentle, but along the northern and western sides of our area this Greensand country falls away to a deep and narrow valley, the bottom of which is occupied by the Gault Clay, again geologically higher but physically lower than the Greensand which dips beneath it. East of Midhurst, however, the Lower Greensand is thin and rises but little above the level of the Wealden plain.

The Gault Clay valley, known in Surrey as the Homesdale, is everywhere overshadowed by the steep uncultivated scarp of the Chalk down, under which the clay dips; on the northern side the chalk escarpment faces southward across the Weald to the northward-facing escarpment of the South Downs on the other side of the area. Once the top of the Chalk scarp is reached the land begins to fall away in gentle slopes towards the Thames on one side or the sea on the other, and a great part of the northern halves of Kent and Surrey is occupied by other formations resting upon the Chalk; first of all by the Thanet sand and pebble beds, which are almost confined to Kent, and then by the London Clay, above which again come the heathy wastes of the Bagshot Sands that are chiefly developed in Surrey. The South Downs are only overlaid by these more recent formations in the flat maritime district of Sussex between Chichester and the sea, and there they are obscured by superficial deposits of Brick Earth.

If we take a central line along the Weald, drawn from near Haslemere to Hastings, then whether we walk southward or northward from that line we shall cross the same strata in the same order, the northern half of the area both in geology and structure being a strict reflection of the southern half, with a few minor local differences. The origin of this very special distribution of the strata is most readily grasped by looking at the section drawn across the Weald from north to south (Fig. 2.) It is easy to see that the various strata which are repeated on either side of the central line must have been at some remote period continuous across the Weald though many hundred feet above the present level of the land. The structure now seen represents the degraded core of a great fold in the strata, the top of which was ground off so as to lay bare the lower strata, just as the slice of a knife will lay bare some of the inner coats of an onion. When that had been done the present outlines of the country were brought about by the usual weathering agencies of frost and rain, leaving the harder strata in ridges while the softer clay beds were washed out to form the Homesdale and the flat areas of the Weald plain. Confirmation of this theory of the formation of the Weald is afforded by a consideration of the river courses, which run in a manner that would not be

FIG. 2.—SECTION ACROSS THE WEALD

expected from the present contours of the land. All the larger rivers in the area under consideration take their rise either in the central High Weald or in the Weald Clay plain below, but though they thus rise or soon flow into the Weald Clay plain, which is never more than 150 feet or so above sea level and forms a continuous valley to the sea, the rivers do not flow along this valley. Instead they cross the clay until they reach the sandstone ridge, through which they cut comparatively narrow steep-sided gorges, and having thus reached the Gault valley, they again cut across it and make their way northward through the North Downs or southward through the South Downs in narrow gorges which are practically at right angles to the range of hills they are traversing. So they find their way to the sea or the Thames. The Medway forms a typical example; its longest tributaries rise in the High Weald near Crowborough and behind Goudhurst and Tunbridge Wells, they meet in the neighbourhood of Yalding on the Weald Clay at a height of about 50 feet above sea level, there they are joined by another tributary, the Beult, which took its rise in this same clay plain almost within sight of the Channel. The united river now flows northward to Maidstone through the Greensand ridge, which rises to 400 feet or so on either side of the narrow valley. Near Maidstone the Medway is joined by a tributary which has been flowing laterally down the Gault valley, but the river continues its northward course and breaks through the North Downs, which here rise to over 600 feet above sea level. These characteristic "gaps" through the Chalk are made by all the rivers, the Wey, the Mole, the Darent, the Medway, and the Stour on the north side, the Arun, Adur, the Ouse, and the Cuckmere on the south side, and they can only be explained by supposing the river courses to have been laid down before the present contour of hill and valley had been carved out by the weather. As indicated above, the Wealden area must have originally been an east and west fold of the strata, much higher than at present, down the sides of which the rivers began to run northward and southward across the outcrops of the Weald Clay, Greensand, Gault, and Chalk. The softer clays were eroded and removed much more rapidly than the Greensand and the Chalk, which were left standing as ridges, except where they were crossed by the rivers. Along their course, however, the rivers kept cutting down their beds to keep pace with the lowering of the softer country in which they took their rise, and as they had to concentrate their eroding powers in deepening the valley they were unable to wander much or enlarge their beds laterally, with the result that they continue to flow in comparatively steep-sided gorges through the sand and chalk.

The result of this earth architecture is that the area covered by Kent, Surrey, and Sussex is divided naturally into a series of strips of country running approximately east and west, each strip representing the outcrop of one geological formation and possessing much the same general level, soil and vegetation. The strips vary in breadth and are often narrow, moreover since the strata are as a rule alternately soft and hard, there is generally a sharp rise or fall in passing from one to the other. The strips are

also divided transversely by the river valleys noted above, so that the whole district shows considerable variations of level and is hilly and steep out of all proportion to the actual height ever attained by any part of the land.

The Weald.—It has already been indicated that the centre of the area is the high ridge of the Weald which begins near Horsham and reaches the sea near Hastings; towards the west the ridge is not very high, but it culminates in Crowborough Beacon (803 feet) and from thence to the sea maintains a considerable elevation, generally above 500 feet. Geologically it consists of alternating sand and clay beds belonging to the Hastings series; westward the sand predominates and is divided into the Ashdown and Tunbridge Wells Sands, though both divisions give rise to similar soils; on them lie the heathy wastes of St. Leonards, Tilgate, and Ashdown Forests. In East Sussex the soil is generally heavier and carries much woodland; actual clay beds, distinguished as Wadhurst Clay, are exposed in the valleys, but all over the high Wealden area the soil is much of the same type, only varying in the relative predominance of fine sand or clay. Throughout the region the streams have cut very deep valleys, the actual wall-sided ravine in which the stream flows being generally termed a "gyll." The bottoms of the larger valleys are occupied by fertile meadows and hop gardens, in marked contrast to the poor grass and woodland of the higher ground. This region formed the heart of the forest of Anderida, the Andredes-Weald of the Saxons, whence the name of Weald has survived, and its tangled woods and deep clayey bottoms long formed a barrier against invasion and movement. The Romans appear to have penetrated it very little, though there is some evidence that they engaged in the iron smelting, but the itineraries describe the road from Pevensey to Chichester and London as having gone by way of Southampton, in spite of the paved causeway which has been traced from Chichester to Dorking. For many generations the Weald forest formed an effective barrier between the Jutes who had settled in Kent and the South Saxons who occupied the South Down Country. Its forest character is shown by the prevalence of names terminating in -den, -hurst, -chart; its late settlement is visible in the great size of the parishes and in the scanty records in Domesday Book of any manors then existing, only eight being found in the whole Weald of Kent. Agriculturally this district is a region of woodlands (oak on the heavier soils, chestnut and birch on the sandier tracts) and grass, most of it comparatively poor pasture. In the valleys, however, there are rich alluvial meadows, and above them the lower slopes of the hills carry a deep soil of considerable fertility, on which a good many hops are grown, though the area has shrunk very rapidly of late years. Comparatively little land is under the plough, but good orchards and plantations of black currants are not uncommon. Despite the fertility of its valleys this district has never borne a high reputation for its farming. Arthur Young, writing in 1784, says that "The Weald of Kent which comprehends so great a part of the county, is under very bad management." thus comparing

it unfavourably with the excellent husbandry of that part of Kent between London and Canterbury and Dover. Caird again, seventy years later, declares that "the husbandry of the Weald district is very similar to that of Surrey, the farms being small, the land ill drained, half cultivated, and inadequately stocked; while the face of the country is too much occupied by wood, and cut up by overgrown hedgerows." Cobbett was more pleased with it and described the country between Worth and Tunbridge Wells in 1823 as "thus divided, three tenths woods, two tenths grass, a tenth of a tenth hops, and the rest cornland."

It is of this High Weald that Rudyard Kipling writes:

"Oh! my heart is set on a ferny hill
Twixt a liddle low shaw and a great deep gill
Oh hop bine yaller and woodsmoke blue!
I reckon you'll keep it middling true."

From the industrial point of view this district was once famous as the seat of both a cloth and an iron industry. The cloth trade seems to have begun in the fourteenth century and lasted on until the eighteenth; its sole memorials are certain cloth halls and similar evidences of old prosperity in the towns of the Weald. The iron ore was won chiefly from the Wadhurst Clay and the woodlands supplied the charcoal for smelting. The industry was at its height in the sixteenth and seventeenth centuries, and declined with the employment of coal for iron smelting in Durham; by the beginning of the nineteenth century it was practically dead, though the last furnace at Ashburnham was not blown out until 1828. All over the district the large "hammer ponds," in which water was impounded to drive the tilt hammers of the forges, are still to be found, though in many cases they have been drained and have gone back to cultivation. Old slag heaps are also to be found hidden away in the woods; those which were more accessible have generally been used up for road mending. The iron making was not confined to the Wealden area proper; the Lower Greensand, especially in West Surrey, also yielded iron ore, and even some of the superficial formations on the Chalk were worked for that purpose.

The sand and clay area of the High Weald is surrounded by the broad valley of the Weald Clay, a comparatively level area with a few gentle undulations caused by thin layers of harder Paludina limestone interbedded with the clay. As the whole of this district lies low and the Weald Clay is both thick and impervious—a true heavy clay with but slight slopes—this valley is mainly occupied by wet unproductive grass-land, with a large proportion of woodland, mainly carrying oak and ash. Drainage is necessary before the land can be cultivated with success, but is not always easy owing to the absence of fall. In previous centuries this country, and to a lesser degree the High Weald, were notorious for the bad condition of the roads, due to the heavy nature of the soil, the lack of hard material for road making, and the continued traffic from the iron furnaces. Hasted, writing, at the close of the eighteenth century, records that "the roads were of 50 to 60 feet wide with a breadth of greensward on each side; hedges filled with oak trees hanging

over the road, with stone causeways for foot passengers. When they became dry in summer they were ploughed up and laid in a half circle to dry, the only amendment they ever had."

Cobbett, in 1823, describing a journey from Ewhurst, in Surrey, to Reigate, says "the first three miles was the deepest clay I ever saw . . . . It took me a good hour and a half to get along these three miles . . . . This is the real weald, where the clay is *bottomless;* where there is no stone of any sort underneath. . . . All along here the oak woods are beautiful. I saw scores of acres by the roadside, where the young oaks stood as regularly as if they had been planted . . . . a county where, strictly speaking, only three things will grow well,—grass, wheat, and oak trees."

Again, Marshall writes of the same district in 1791, "Except the more public ones as between Godalming and Petworth; Petworth and Horsham; and Horsham and Dorking, this district may be said to be without roads. In every part—lanes are sufficiently numerous, but . . . . lie in their natural state; worn into gullies and trodden into sloughs. Even in the spring and early summer months, they appear intolerable to a stranger; and, in winter, are barely passable to the natives of the country."

Agriculturally the land is mainly in grass; the hop and fruit plantations which are common in some places, *e.g.*, near Tonbridge and Paddock Wood, are as a rule situated on beds of alluvial gravel or Brick Earth overlying the clay. These patches of Brick Earth afford the only pleasant prospects to the farmer travelling through the Wealden plain, elsewhere he sees little but cold and wet grass land, carrying the poorest quality of herbage of a dreary infertile aspect, which not inadequately reflects the fact that many generations of cultivators have found this land both expensive and ungrateful to handle. In 1791, Marshall sums up his impressions of the Weald Clay country "at present it is disgusting to ride over, and most discouraging to farm in." Many continental travellers on the main line of the South Eastern Railway, which between Ashford and Tonbridge runs along the Wealden plain, must wonder where the boasted fertility of Kentish land exists.

The Sand Ridge.—Round the outer edge of the Weald Clay the escarpment of the Lower Greensand rises steeply to a considerable height, except near its northern extremity in Kent and again at its other end in Sussex, where the formation is thin and but slightly developed. Near Sevenoaks the Greensand ridge reaches a height of 810 feet, and though between Limpsfield and Dorking the level is lower again, immediately to the west this formation assumes much greater importance and rises to a height of 967 feet on Leith Hill and again to nearly 900 feet on Hindhead and the neighbouring hills of West Surrey. Geologically speaking the Lower Greensand is divided into four formations; next the Weald Clay comes a thin bed of Atherfield Clay, which is agriculturally indistinguishable from the Weald Clay, though it has been credited with a greater value because of the carbonate of lime it contains. Above the Atherfield Clay comes the main

division of the series—the Hythe Beds—a calcareous Sandstone in East and Mid-Kent, where it is known as the Kentish Rag, which west of Sevenoaks becomes more coarsely grained and devoid of carbonate of lime until in West Surrey it forms an area of barren sandy heaths and is little distinguishable from the overlying Folkestone Sand. The Hythe beds in East Kent are succeeded by a clay formation known as the Sandgate Clay, which crops out in a small area of low-lying wet land in the country between Sandgate and Ashford, and in Godington Park, and again in West Sussex. Several small lateral tributaries of the main rivers run along the outcrop of this formation. The Sandgate Beds in Kent are mainly covered by grass and are of little importance agriculturally; further west it is difficult to distinguish them from the other Greensand formations, though there are small areas near Nutfield in Surrey, where Fuller's Earth is worked, and near Godalming, which are sometimes regarded as belonging to the Sandgate Beds. Near Godalming the Sandgate beds form a calcareous rock called the Bargate Stone, very similar to the Kentish Rag, and yielding like it a fertile soil.

The highest member of the Lower Greensand series is known as the Folkestone Sand, a coarse grained ferruginous sandstone which weathers down into an extremely light infertile soil, largely covered by uncultivated heaths and wastes all the way from Folkestone to Woolmer Forest. In places, as in the Maidstone district, the Folkestone Sand areas have been reclaimed, and by the help of heavy manuring have been made into fertile land for growing small fruit, but as a rule their lightness and their elevation render them unremunerative to cultivate.

No area within the limits of our survey varies so much in its fertility and agricultural character as that occupied by the Lower Greensand; in East and Mid-Kent, where the Kentish Rag is both fine grained and contains carbonate of lime, it yields on weathering an extremely fertile soil, suitable for hops and particularly for fruit. The valley of the Medway between Yalding and Maidstone, with the land for a few miles back on either side of the river, more than perhaps any other part of Kent deserves the name of the Garden of England, so thickly is it set with highly farmed hop gardens and well managed fruit plantations. It is of this district that Cobbett writes: "This is what the people of Kent call the *Garden of Eden*. It is a district of meadows, cornfields, hop gardens, and orchards of apples, pears, cherries, and filberts, with very little of any land which cannot, with propriety, be called good. There are plantations of chestnut and of ash frequently occurring; and as these are cut when long enough to make poles for hops, they are at all times objects of great beauty. . . . From Maidstone to Mereworth, I should think there were hop gardens and orchards two miles deep, on the side of a gently rising ground, and this continues with you all the way from Maidstone to Mereworth. The orchards form a great feature of the country," and Cobbett's description holds good to-day.

The steep scarped face of the Greensand ridge, with its southern exposure, is particularly valuable for fruit; even the

Weald Clay which comes pretty high up the face of the escarpment is sufficiently overlaid by a downwash of sand to form a valuable soil to the foot of the hill. West of Sevenoaks, however, the Greensand ceases to have much agricultural value, and in the areas of its greatest development (the section from Leith Hill nearly to Guildford and the region bounded by Hascombe Hill, Crookesbury Common, Woolmer Forest, and Hindhead), only the valleys are cultivated because there the rain-wash and the streams have accumulated some little depth of soil. The rest is open heath covered with heather and gorse or woodland of Scotch fir, larch, and birch. These are Cobbett's "rascally heaths": Hindhead itself, most favoured of residential districts, being described by him as "certainly the most villainous spot that God ever made."

The highest part of the Greensand ridge is always near the escarpment, from which the country gradually falls until the Gault valley is reached, a narrow valley often closely hemmed in by the sand hills on one side and the chalk escarpment on the other, especially in the western half of Surrey, where the dip of the strata is high and the outcrop of the Gault in consequence very narrow. This little valley formed by the soft Gault Clay, the Homesdale, is one of the most beautiful features in the scenery of the South of England. On the one hand the chalk escarpment rises steeply, with its characteristic smooth curves dotted with juniper and lined with yew, generally crowned at the summit with a beech wood; on the other side are the sand hills with their entirely different vegetation, in Surrey of dark pine and heath, in Mid-Kent of chestnut and fruit plantations, while the botton is occupied by rich soft grass-land with luxuriant trees and by a shelf of fertile arable land at a slightly higher level.

The Gault itself forms in the main a heavy black clay, not so intractable as the Weald or London Clays, because in its upper beds it contains carbonate of lime, yet on account of its situation it is generally very wet and lies in the main in pasture. Only in the extreme west of our district does it cover any considerable area, and there it underlies Alice and Alder Holt Forest, permanent woodland, famous for the quality of its timber. In West Sussex it is thus described by Arthur Young the second, "At the northern extremity of these chalk hills, and usually extending the same length as the Downs, is a slip of very rich and stiff arable land, but of very inconsiderable breadth; it runs for some distance into the vale before it meets the clay. The soil of this narrow slip is an excessively stiff calcareous loam on a clay bottom; it adheres so much to the share and is so difficult to plough, that it is not an unusual sight to observe ten or a dozen stout oxen, and sometimes more, at work upon it. It is a soil that must rank among the finest in this or any country, being pure clay and calcareous earth; to the eye it appears whitish, from the mixture of chalk. Some of it that appears of a blacker nature, is less mixed with that substance; it is generally deep and under it is a pure clay."

Above the Gault the great Chalk formation begins, but agriculturally it is difficult to distinguish the passage from the Gault to the shelf of land representing the outcrop of the Upper Greensand and the Chalk Marl, the lowest member of the cretaceous series.

The Upper Greensand is barely recognisable in Kent, but as soon as the Surrey border is crossed it is found as a narrow shelf or terrace of free-working loam with sometimes a sandy character, immediately above the heavy Gault Clay. In the neighbourhood of Merstham and Reigate it is well esteemed for arable farming, but west of Dorking the outcrop becomes so narrow that it is of little importance agriculturally, though until quite recent times as far as Farnham its presence was marked by occasional small hop gardens. West of Farnham in Hampshire the Upper Greensand broadens out round Bentley and Selborne into a diversified area of loamy soil which has a great reputation agriculturally, carrying some of the finest hop gardens and fruit plantations of that fertile district. Below the South Downs, again, the Upper Greensand forms a shelf of fertile land mostly under the plough. The Upper Greensand terrace passes without change of level into the Chalk Marl, which gives rise to an area of highly calcareous heavy soil all through Kent, Surrey, and Sussex immediately below the escarpment formed by the harder Middle or Grey Chalk; agriculturally it is land of good quality for arable farming and is largely under the plough.

The Downs.—As one passes from the narrow valley occupied by the Gault, the Upper Greensand and the Chalk Marl, up to the steep face of the down, there is a great and sudden change of character in the land; the arable cultivation is at once exchanged for poor grass and sheep walk, which is in many cases overrun by the native shrubs so characteristic of the chalk—the Juniper, the Wayfaring tree, the Dogwood, and the Beam tree, all enlaced with the trailing wreaths of the Clematis. The summit of the ridge is in Kent rarely less than 600 feet above sea level, it rises to nearly 900 feet in Surrey just beyond the Kent boundary, but falls considerably from that height between Guildford and Farnham, where the great dip of the strata causes the chalk to form a narrow ridge—the Hog's Back—only a few hundred feet broad at the top. Elsewhere the country opens out beyond the edge of the escarpment into a broad flat plateau; on the South Downs this is mostly unenclosed sheep walk, but on the North Downs woodland and small enclosures predominate. These differences are due to the fact that the land on the summit of the North Downs near the escarpment is very largely covered with superficial deposits of clay or sand (the red "Clay-with-Flints" and the "Lenham beds)" which carry an entirely different type of vegetation from that associated with the thin loamy covering of the chalk proper. It is only on the lower slopes away from the escarpment, as on the east side of the Elham Valley (which makes a great dividing line between the upper White chalk and the middle Grey chalk in East Kent) or the country by Sutton and Epsom in Surrey, and, again, in the Isle of Thanet, that the North Downs are, like the South Downs,

free from these superficial deposits. But all along these lower northern slopes the Chalk carries a pretty deep deposit of loam, so that the country, although largely unenclosed and free from woodland, is mainly under the plough. Cobbett describes himself as traversing close to Dover " with very little interruptions, very few chasms, . . . eighteen square miles of corn," and, again, " when I got upon the corn land in the Isle of Thanet I got into a garden, indeed. There is hardly any fallow, comparatively few turnips. It is a country of corn. A great many pieces of lucerne and all of them fine. All was corn around me. Barns, I should think, two hundred feet long; ricks of enormous size and most numerous; crops of wheat five quarters to the acre on the average." Cobbett also notices the very different aspect presented by the Clay-with-Flints, which covers so much of the North Downs and occurs again in Herts and Hampshire. " In coming up the chalk hill from Westerham, I prepared myself for the red stiff clay-like loam, the big yellow flints and the meadows; and I found them all. I have now gone over this chalk-ridge in the following places . . . (Coombe, Hampshire; Highclere, Kingclere, Ripley, Dippinghall, Merrow, Reigate, Westerham, Godstone, Sevenoaks, Hollingbourne, Folkestone). Everywhere, upon the top of it, I have found a flat, and the soil of all these flats I have found to be a red-stiff loam mingled up with big yellow flints. A soil difficult to work; but by no means bad, whether for wood, hops, grass, orchards, or corn. . . . Upon these hills I have never found the labouring people poor and miserable, as in the rich vales. All is not appropriated where there are coppices and wood, where the cultivation is not so easy and the produce so very large."

It is the stretch of chalk which extends from the east of the Arun to the sea at Beachy Head which forms the true down country of gently swelling rounded hills with open sheep walk of the most elastic turf on the heights and great unenclosed arable fields round the homesteads in the hollows. Hardly a tree is to be seen, and in many places the beautiful turf is entirely smooth and bare, though in the east gorse is common, intermingled further west with stunted thorn bushes and juniper, together with occasional patches of heather. Gilbert White's appreciation of the South Downs is often quoted, " Though I have now travelled the Sussex-downs upwards of thirty years, yet I still investigate that chain of majestic mountains with fresh admiration year by year; and think I see new beauties every time I traverse it . . . For my own part, I think there is somewhat peculiarly sweet and amusing in the shapely figured aspect of chalk-hills, in preference to those of stone, which are rugged, broken, abrupt, and shapeless."

Though we should not nowadays call the South Downs a chain of majestic mountains this passage well expresses the very strong and enduring impression which these heights make on anyone who traverses them, especially when they are viewed from the north, so that the great roll of the escarpment and the buttress-like hills are extended full in face. The special and intimate

charm of the country is caught in Mrs. Marriott Watson's well-known lines:—

"Broad and bare to the skies,
The great down country lies,
Green in the glance of the sun,
Fresh with the keen, salt air;
Screaming the gulls rise from the fresh turned mould,
Where the round bosom of the wind-swept wold
Slopes to the valley fair.
Where the pale stubble shines with golden gleam,
The silver ploughshare cleaves its hard won way
Behind the patient team.
The slow black oxen toiling through the day;
Tireless, impassive still
From dawning dusk and chill
To twilight grey.
Far off, the pearly sheep
Along the upland steep
Following the shepherd from the wattled fold,
With tinkling bell notes falling sweet and cold
As a stream's cadence, while a skylark sings
High in the blue with eager, outstretched wings,
Till the strong passion of his joy be told."

From Ditchling Beacon to Beachy Head the finest of this down country is to be found, and the sweeping downs that culminate in Firle Beacon form the most beautiful group of all.

The most notable feature of the chalk country is its dryness and lack of running water; springs break out at the foot of the escarpment where the Marl or the Gault hold the water, soaking through the porous rock, but these springs, though they have cut remarkable Coombes—deep circular-ended valleys—back into the chalk, are never strong, because the chalk is dipping away from the face of the escarpment and so leading the water in the opposite direction from the spring. In the mass of the Chalk the valleys are generally dry, with great accumulations of unworn flints at bottom; only when they cut deep enough to reach the permanent water table of the Chalk, 200 to 300 feet below the general level of the plateau, do springs, often inconstant "Nailbournes or Winterbournes," begin to flow. Except for the Cray, the Wandle, the Little Stour and its tributaries, streams which rise on the Chalk, and the large rivers which cut through the Downs, no running water is to be seen, and on the top of the plateau the wells have to be sunk 200 to 300 feet before water is reached. The higher levels of the chalk country have but little value for agricultural purposes; the absence of water renders it difficult to graze cattle, on the Chalk itself the soil is too thin for profitable cultivation, while the Clay-with-Flints is both cold at that elevation and heavy working. The thinner soils form healthy sheep walks, while the Clay-with-Flints is largely covered with copse wood.

Camden (1586), writing of Kent, says: "The inhabitants distinguish it as it lieth south-east-ward from the *Tamis*, into three plots or portions, they call them steps or degrees; the upper

whereof, lying upon *Tamis* they say is healthfull, but not so wealthy*; the middle they account both healthfull and plentifull†; the lower they hold to be wealthy but not healthy‡; as which for a great part thereof is verie moist, yet it bringeth forth rich grass in great plentie."

Along the gently sloping northern flank of the North Downs through East Kent from near Deal to Sittingbourne, Rochester, and Gravesend, comes a belt of irregular diversified country where the Thanet Sands with their accompanying pebble beds rest in strata of varying thickness upon the Chalk. In places the hills they form are capped with London Clay beds; these Tertiary deposits are also covered in many places by thick beds of Brick Earth, high-level deposits from a period when the Thames and its tributaries were more important streams than they are now. In this area the surface is very irregular and the outcrops of the various strata are never extensive, because they have been cut up transversely by the old drainage system from off the chalk; the result is that one may pass rapidly even within the boundaries of a single farm from bare Chalk to Clay-with-Flints and Brick Earth, from the deep loamy Thanet Sands to the light pebbly soil derived from the higher Oldhaven beds, and from that up to the heavy London Clay. But in the main this is extremely fertile country; the Thanet Sands and the Brick Earth form almost ideal soils for all purposes and are mainly occupied by hops and fruit, while the lighter Oldhaven sands do well for small fruit and vegetables. This belt forms the other great fruit-growing region of Kent—particularly is it famous for its cherry orchards. It is mainly to this area that Arthur Young refers: "When the excellent husbandry of Kent is mentioned, it must always be understood in a very limited sense. From London to Canterbury, and from Canterbury to Sandwich, spreading a little towards Deal and Dover, is a line of very excellent management, which extends to the river Thames and to the sea, and includes the whole isle of Thanet, but it spreads very little to the south of that road." Nearer London the Thanet Beds become almost wholly made up of coarse sand and pebbles, forming a soil of little value for cultivation and often left unenclosed like the commons of Hayes, Woolwich, and Blackheath; further west, still in Surrey, the formation is only recognisable by geologists.

These formations are only seen to a modified extent on the Sussex Chalk, but all the country between the sea and a line drawn roughly from Worthing to Chichester—the flat maritime district of Sussex—is covered by deposits corresponding to the Brick Earths of East Kent, resting upon the Chalk or upon thin Tertiary beds before the Chalk is reached. Arthur Young describes the country, which passes off into the true alluvial flats of Selsea—as "an extensive arable vale of singular fertility . . . The nature of the soil, which is probably equal to any in the kingdom, is a rich loam, either a brick earth or gravel."

Reverting to the North Downs, the London Clay, which succeeds the Thanets, forms but a poor soil; in East Kent it often

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* *i.e.*, the Chalk. † *i.e.*, the Ragstone. ‡ *i.e.*, marshes on the seaboard.

occurs at a considerable elevation and then is chiefly left in woodland or in poor unproductive grassland. In Sheppey the London Clay used to be cultivated and would in favourable seasons yield great crops of wheat and beans; it has now, however, mostly gone back to grass. South-west of London these clay beds are to a large extent obscured by the gravels and brick earths, as on Mitcham Common, but a little further west near Malden they become clear again and form the broad shallow valley along which the new line to Guildford runs, and the narrower but similar valley north of the Hog's Back to Aldershot.

The London Clay land has but little agricultural value; upon it in Surrey there are extensive commons, such as those at Ashtead, Epsom, and Clandon, and even when enclosed it is mainly poor grass-land. The look of Ashtead Common will show what miserable poor soil the London Clay affords in this area when it is in an unimproved state, but the proximity of the chalk on the one hand and London with its cheap supplies of dung and refuse on the other, have been the means of ameliorating much of it into a rich strong loam, carrying good wheat and grass, but nowadays chiefly occupied by dairy farmers. Cobbett describes some of it in its early unimproved condition:— "About a mile on this side of Sutton there are two fields of as stiff land, I think, as I ever saw in my life. In summer time this land bakes so hard that they cannot plough it unless it be wet. When you have ploughed it, and the sun comes again, it bakes again. One of these fields had been thus ploughed and cross-ploughed in the month of June, and I saw the ground when it was lying in lumps of the size of portmanteaus, and not very small ones either." West of Guildford the London Clay becomes somewhat lighter in character, and though poorly farmed it is more amenable to cultivation.

The Heaths.—The London Clay is capped by the Bagshot Sand, a formation which is divided geologically into upper, middle, and lower, but which varies but little in character, consisting of soft, coarse-grained, ferruginous sandstones almost devoid of either clay or carbonate of lime. In Kent there are a few caps of Bagshot Sand on the London Clay in Sheppey, but it does not occur again until the similar caps on which Wimbledon Common and Richmond Park are situated. At Esher the main mass of the Bagshot Beds begins; it stretches, with some interruptions due to the Brick Earths and gravel of the valleys of the Mole and Wey, through the long chain of barren heaths and commons to the Cobham Ridges, Windsor Park, and on into Hampshire. The Bagshot Beds form true heath country of black peaty sand covered with a natural growth of heather and Scotch fir, very similar in external appearance to the Lower Greensand wastes further south. A great part of it is in waste and common, and where it has been enclosed it is mainly for residential purposes; the land that is under cultivation consists of certain more loamy areas where the sand contains a little clay, or the bottoms of the valleys where a little soil has been accumulated by rain wash. Poor wet meadows border the streams, and above them

come a few indifferent arable fields. Here and there in the area are patches of brick earth, which have usually been picked out by nurserymen and fruit growers. The whole of this country has little or no agricultural importance, though it has long formed a favourite residential district. It was on this country that Cobbett vented the utmost of his exasperation; from the farming point of view it was obviously worthless, "spewy sand," while it had been planted in the larch which he abominated and was even then becoming a favourite district for the villa residences that, to his eye, stood for the two greatest of England's curses—the funds and the stock-jobbers. "*Windsor Forest*, that is to say, as bleak, as barren, and as villainous a heath as ever man set his eyes on."

The Bagshot Beds, Clay-with-flints, London Clay, Chalk, and Lower Green sand, form a large area of infertile land in Surrey, while the Homesdale to the south, the Farnham district to the west, and the Thames valley to the north have always been productive. So Camden writes in 1586 of Surrey: "Likened it is by some unto a course freese garment with a greene gard, or to a cloath of a great spinning and thin woven, with a greene list about it, for that the inner part is but barraine, the outer edge or skirt more fertile."

The Marshes.—Though the Bagshot Beds form the most recent of the true geological formations developed in our area, much of the ground is covered by yet more recent "drift" deposits, which have been formed in our own or in the immediately preceding geological epoch. Such are the Clay-with-Flints we have already described on the North Downs, the Brick Earths of East Kent and the Thames Valley, and the alluvial beds which underlie the flat meadows bordering all the rivers. These alluvial beds partake of the character of the neighbouring formations from which they have been derived, but they will also contain material brought from other formations higher up the stream's course. They all have certain characters in common, though they vary from very light soil, as in the Wey valley, where they are derived from the Bagshot Beds, to heavy clays, as along the sides of the Wealden Rivers. The ordinary river valley alluvium is not, as a rule, very extensive, but the coasts of Kent and Sussex are distinguished by a special development of alluvial land known as the Marshes. These are seen on the largest scale in Romney Marsh, which has an area of nearly 120 square miles, but in a similar, but smaller way, they extend all along the mouth of the Thames and the Medway, inside the Isle of Thanet and the mouth of the Stour; further west comes the Pevensey Level, which on the other side of the central Wealden Hills corresponds to Romney Marsh. These are not salt marshes, but rich grazing lands which are elaborately drained by a system of ditches and sewers, communicating with the river channels or the foreshore only at low water, since the greater part of these marshes is below the level of the highest tides and is only protected from the incursions of the sea by a sea wall. All these marshes have been reclaimed from the sea in comparatively recent times; for example, though the

eastern half of Romney Marsh is pre-Roman, the district west of the Rhee Wall, known properly as the Walland, Denge, and Pett Levels, has all been "inned" within historic times, some of it as late as the eighteenth century.

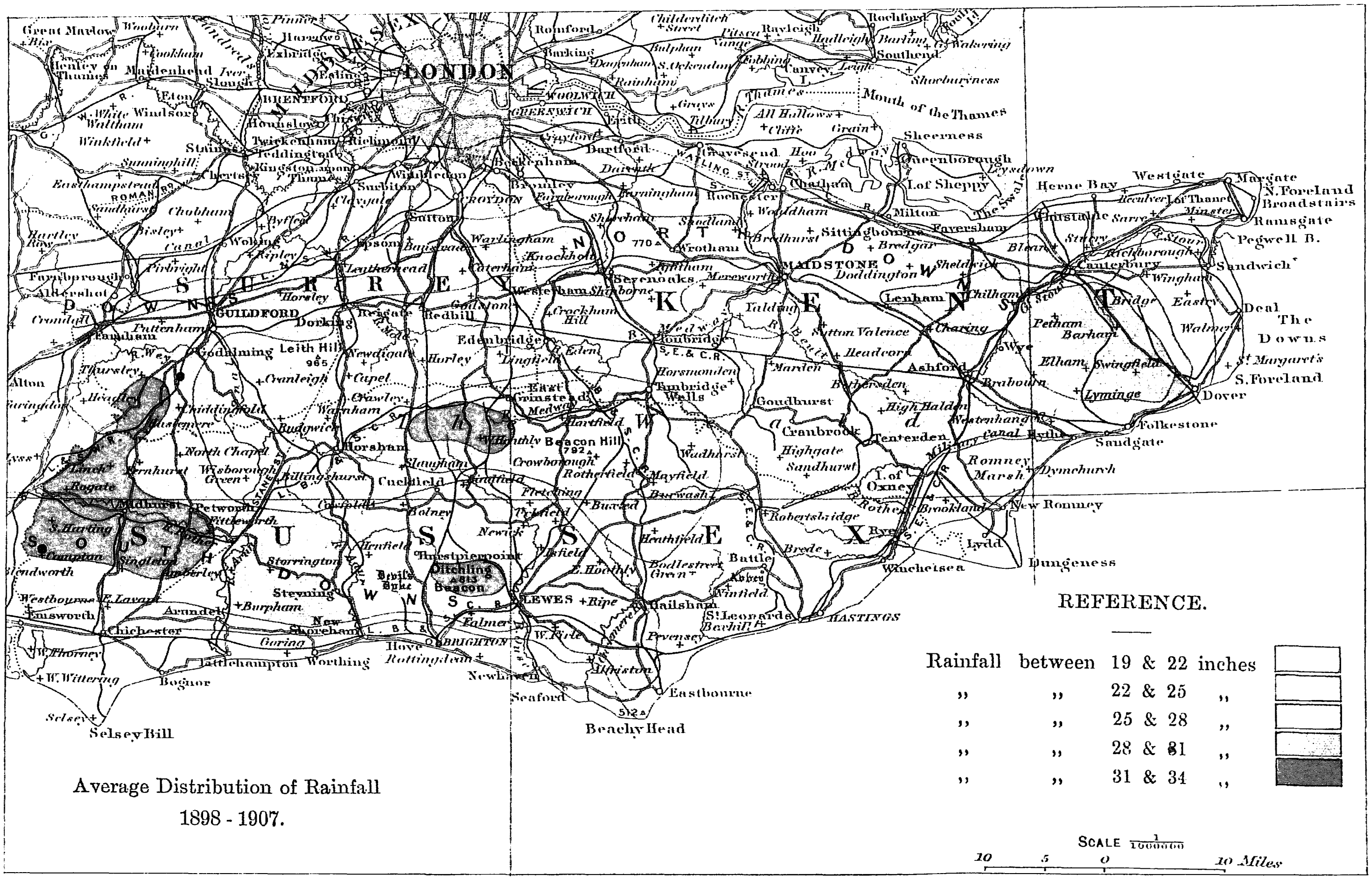
Cobbett thus describes Romney Marsh in his day: "The next village was Old Romney, and along here I had, for a great part of the way, corn-field on one side of me and grass-land on the other. I asked what the amount of the crop of wheat would be. They told me better than five quarters to the acre. I thought so myself. . . . I never saw corn like this before. . . . They have here about eight hundred large, very large sheaves to the acre. . . . In a garden here I saw some very fine onions, and a prodigious crop, sure sign of most excellent land.

Though the marsh land is still cultivated to a certain extent, it is in the main down in permanent pasture; in Kent these wide grassy flats are the true home of the Kent or Romney Marsh sheep, just as the Pevensey Level is stocked with Sussex cattle; many of the pastures are famous for their richness, and will fatten either sheep or bullocks.

In addition to the soils thus described there are a few acres of blown sand fringing the marshes, and between the barren dunes and the marsh proper there is often a strip of very light land highly esteemed for its earliness and freedom from frost, qualities which it owes to its sandy nature and close proximity to the sea, but the area is too small to give it more than local importance.

Rainfall.

The rainfall of the district shows considerable variations, and these have some bearing upon the cropping and style of agriculture. To illustrate the distribution of rain, the map (Fig. 3) has been put together from the records contained in "British Rainfall" for the ten years 1898-1907. Though a ten-year period is not sufficient to establish the average rainfall for any place, Dr. H. R. Mill considers that it will provide true relative figures, consequently the map may be taken as showing the comparative distribution even though the stated fall at any place may prove to differ by an inch or two from the true average over a long period. The period in question was rather drier than the average (Rothamsted average was 26·75 inches for 1898-1907, against 28·12 for the 53 years 1853-1907; Greenwich 22·93 for 1898-1907, against 24·12 for 69 years 1841-1909), hence all the figures are about an inch below the true average. The real imperfections of the map come from the poverty of the data; despite the apparent length of the list of rainfall observers in the three counties, it is only when one comes to plot the results on a large scale map in order to map the average distribution of the rain that one realises how many more observations are wanted before a true picture can be drawn. In consequence, the map we have constructed must be regarded as rather sketchy and problematic in its details; in several places we could indicate probable errors which cannot, unfortunately, be corrected for want of evidence. The main features are, however, clear enough to show that the rainfall is intimately bound up



Ordnance Survey, Southampton 1911.

FIG. 3.—RAINFALL MAP—SOUTH EASTERN COUNTIES, ENGLAND.

with the topography, for within the limits of our area the rainfall varies from 36 inches on the high chalk South Downs in the extreme S.W. of Sussex to less than 20 inches along the seaboard of the Thames estuary. There are three factors inducing variation:—

(1.) The rainfall increases with elevation. On the southern slope of the South Downs in Sussex the rainfall, which is 22 inches or less on the seaboard, rises inland step by step until it reaches 35 inches or so on the highest parts of the Downs where the elevation is 600-800 feet.

(2.) The rainfall decreases from west to east. There are no records of less than 22 inches in the maritime district of Sussex, whereas the seaward part of Romney Marsh at the same elevation shows a considerable area with a rainfall below 22 inches.

(3.) The rainfall is less on the northern and eastern sides of the range of hills, because the chief rain-bringing winds are from the S. and S.W., and they discharge their rain on the exposed side of the ridges. This latter proposition is illustrated by the fact that the rainfall is lower in the northern than in the southern half of the Weald clay plain because of the Wealden Hills between, and that it is still lower in the Thames Valley when the North Downs have been crossed.

A belt of high rainfall, over 28 inches, occupies the whole range of the South Downs, and extends some way into the low Weald country beyond. This belt continues through the high Greensand country in North-West Sussex and S.W. Surrey to the North Downs and the Greensand range as far as Leith Hill. Along the North Downs it extends for some distance into Kent, but appears to stop at the Darenth Valley, not beginning again until the high chalk plateau of East Kent is reached, where it widens out into a broad area between Canterbury and Dover. The High Weald in Mid-Sussex has a rainfall above the 28-inch limit, as also have parts of the elevated Greensand ridge about Crockham Hill in Kent. In the extreme west there is a small area of still higher rainfall, above 31 inches, occupying the top of the South Downs and the elevated Greensand country about Midhurst, Rogate, and Haslemere. Data are lacking for the whole of the South Downs, but there is evidence of another area above 31 inches on the downs west of Lewes, and again in the highest part of Ashdown Forest from Crowborough westward. The strip of maritime country in Sussex from the western boundary to Beachy Head receives between 22 and 25 inches of rain; further inland there is an intermediate belt with a rainfall of 25-28 inches before the elevated region with a rainfall of 28 inches and over is reached. The greater part of the low Weald Clay plain has a rainfall of 25-28 inches, and this low rainfall zone is broader on the northern than on the southern side of the High Weald, even extending over the Greensand and the Chalk ridges in the neighbourhood of Maidstone, near which town an area of still greater dryness, with less than 25 inches of rain, occurs where the valley of the Medway and its tributaries crosses the Weald Clay plain. The Bagshot country and the northern part of Surrey beyond the high downs have a rainfall of 22-25 inches, and along the Thames east of

Kingston a strip begins with a still lower rainfall of below 22 inches. The driest area is found along the coast line of North Kent, the Hundred of Hoo, and the Isle of Sheppy; some places in this region have barely 19 inches. This strip of minimum rainfall is continued round the coast, though it becomes very narrow in the neighbourhood of Faversham and Whitstable, but broadens out again to include the whole of the Isle of Thanet and a considerable strip along the east coast of Kent. Romney Marsh and the country a few miles inland also fall within the low rainfall area of 22-25 inches, and a small patch including the extreme seaboard and the Dungeness peninsula receives less than 22 inches.

Thus while all the area must be regarded as dry, between the extreme west of Sussex and the north of Kent there is a variation of 50 per cent. in the rainfall. The extreme dryness of North and East Kent is also accentuated by the light chalky and sandy loams which constitute the bulk of the soils, and by the frequency with which the continental anticyclone overlaps this region in early spring and summer. Anyone familiar with North and East Kent can recall how the east and north winds will often blow for weeks, and even for months, in the early part of the year, their parching influence being only modified when, with sundown. they bring up the sea fogs. Difficult as the low rainfall and excessive evaporation often render farming—for the land has to be very carefully prepared to carry small seeds and root crops through their early stages—it is to its dry climate that Kent owes the excellent quality of its most characteristic products—hops and fruit. The exposure to the bitter and long-continued winds off the North Sea renders North and East Kent a comparatively late country in the spring, despite the large amount of sunshine the district receives. It is only some of the sheltered valleys of the South Downs or the Greensand slopes in West Surrey and Sussex which enjoy a really southern climate and allow of the growth of many exotic plants and shrubs that flourish exceedingly further west, though at a higher latitude.

CHAPTER II.

AGRICULTURE.

The Arable Farming.

An examination of the map (Fig. 42) will show that the arable land of the three counties is very distinctly confined to the lighter and more free-working soils, with the exception of the too-light sands of the Bagshot and Lower Greensand series in the west of Surrey which have remained very largely in heath and waste. Starting from the east, a broad belt of arable land occupies the lower slopes of the Chalk formation from Dover to London, along practically the line of the old Watling Street or the Chatham and Dover Railway. This belt, which has always been the highly farmed and famous region of Kent, is covered by the hazel loams, often very deep, derived from the Chalk itself, by the sandy loams of the Thanet formation, by the extensive terraces of Brick Earth, and the occasional protrusions of the Clay-with-Flints into the lower country. The chalk area which lies between Dover and Canterbury, east of the Elham Valley, is, however, almost free from the Clay-with-Flints, as also is the Isle of Thanet, and both districts are almost exclusively under the plough. Interspersed with the good plough land in East Kent are certain areas of London Clay, often forming caps on hills of Thanet Sand, but broadening out to a considerable area in the Whitstable region and the Forest of Blean. Little of this London Clay is now under the plough; most of it has always been woodland, and what had been broken up in the past has now gone down to grass again. Similarly, a great deal of the heavy clay land in Sheppey, once famous for its wheat and beans, is now grass again. On the higher slopes of the Chalk nearer to the escarpment of the North Downs the superficial formations of Clay-with-Flints become more prominent, but with the increased elevation arable farming is less profitable. Most of this heavy land is consequently occupied by woodland or poor grass, and the arable farming is confined to the valleys, where a lighter soil predominates and more shelter is to be found. In Kent also the Lower Greensand from Sevenoaks eastwards is very largely under the plough, but west of Sevenoaks this formation becomes increasingly barren and covered by woodland and heath. The Mid-Kent arable area is continued over the Weald Clay on the extensive alluvial flats of the old Medway valley and into the High Weald itself along the course of the Medway and its tributaries. Another belt of plough land stretches from the outskirts of London to Guildford along the lower slopes of the Chalk; the adjoining tract of London Clay also possesses some arable land, and in the west of Surrey becomes lighter in texture and more amenable to cultivation. In the neighbourhood of Godalming there is a tract of Lower Greensand which is highly farmed; the rock (Bargate Stone) contains some calcareous matter, and yields a soil of a heavier texture than exists on the open heaths which cover so much of the neighbouring country.

In Sussex an important belt of arable land follows the escarpment of the South Downs and occupies the flat terrace at their foot which

is formed by the outcrops of the Chalk Marl and Upper Greensand; another arable strip parallel with this runs along the lower slope of the Lower Greensand, and is traversed by the road from Petersfield to Midhurst and Petworth. The plough land is even more sharply confined to these particular formations than the map indicates, for the parishes along this line of country consist, as a rule, of narrow strips running at right angles to the outcrop. The parishes begin on the Chalk above the escarpment and run across the Upper Greensand, on which the church is usually placed, to the Gault and the Lower Greensand; in East Sussex, indeed, they stretch still further, over the Weald Clay to the Wealden Sandstones beyond. It has thus been impossible in these parishes to distribute the area under a particular crop strictly according to the formations on which it is located. Moreover, in West Sussex the Weald Clay is much more under the plough than it is in Surrey or in its eastern extension in Kent; as will be seen later, the soil is distinctly lighter and admixed with sand.

But the characteristically arable land of Sussex is the maritime region south of the Downs; practically the whole country south of a line drawn from Shoreham to Chichester is under the plough; north of that line the chalk country proper begins, and is largely covered by grass or wood, the hollows and the valleys, however, both in this part of West Sussex and in the more eastern region up to Beachy Head, are generally in cultivation.

Although the region under consideration is largely devoted to arable farming, it has not escaped from the great change of ploughland to grass which has been going on in England during the last generation (see Fig. 4). In 1872 the arable land under the plough reached its maximum; there was then over a million acres in the three counties as compared with a little less than two-thirds of a million of permanent grass land, but by 1909 these relations had been almost exactly reversed.

—	1872.		1909.	
	Arable.	Grass.	Arable.	Grass.
Kent	445,022	280,568	305,005	432,087
Surrey...	193,343	102,364	101,524	160,345
Sussex...	388,849	262,578	237,567	422,632
Total ...	1,027,214	645,510	644,096	1,015,064

Both actually and relatively Sussex has lost more of its arable land than Kent, 40 per cent. against 31 per cent. lost by Kent, while Surrey had lost the most, 47 per cent., though some of this must be put down to the encroachment of buildings. Despite this latter factor, a large one in these three favourite residential counties, the area under cultivation has increased in both Kent and Sussex, though it has declined in Surrey.

One of the most characteristic features of the arable land of Kent, and to a less degree of Sussex, is the prevalence of the old

Thousand

Thousand Acres

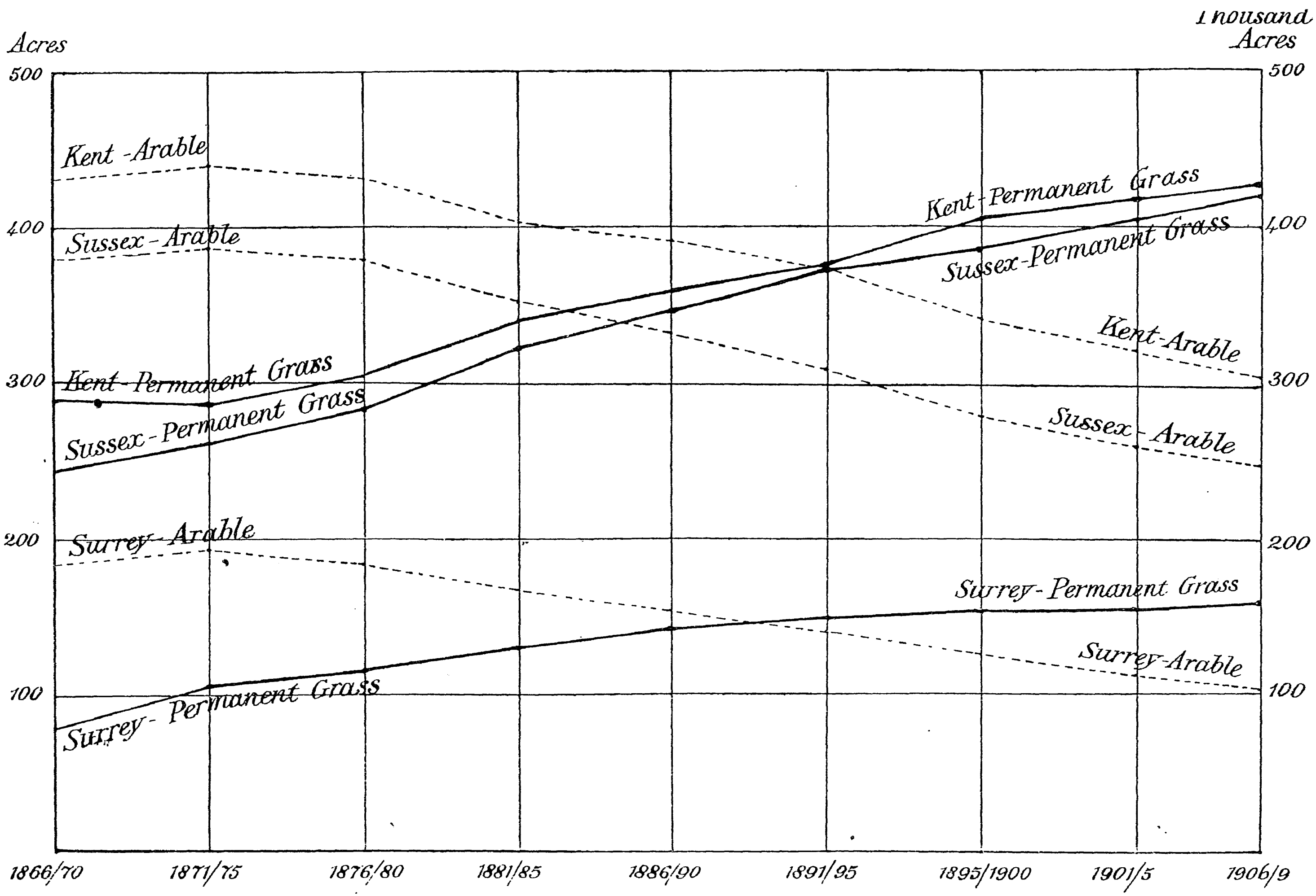


FIG. 4.—DIAGRAM SHOWING CHANGES IN THE AREA OF ARABLE AND GRASS LAND, 1866–1909.

wooden turn-wrest plough. It is thus described by Marshall, and his account will serve very well for to-day:—

> "The plow of Kent is the most extraordinary. Like that of Norfolk, it is common and peculiar to the county, except that the Kentish plow is in use on the hills of Surrey and in some parts of West Sussex.
>
> "To describe this extraordinary production verbally were impossible. Its component parts, and the names assigned them, are nearly equal in number to those of the ship. A North of England farmer, who has never been south of the Thames, would little suspect the purpose for which it is constructed: he would conceive it to be a *carriage** rather than a *plow*. It has a pair of wheels fully as large as the fore wheels of a moorland waggon, and behind them is dragged a long thick log of wood, which slides upon the ground as the hob or shoe of a sledge, with a beam rising high above it which a small farmer of the North would be glad of as a gate-post, comprising in its various parts as much timber and other materials as would build a highland cart.
>
> "This magnificent implement is called the 'Kentish Turn-wrest Plow.'"

Photographs of the implement as it is found to-day in East Kent are given in Figs. 5 and 6.

On the heavier lands of the Weald and into Sussex a similar foot plough is commonly used, which only differs from the Kentish plough proper in being somewhat lighter and possessing no wheels, which would clog up on the heavier land.

Every agricultural writer has inveighed against the Kent plough with its three and four horses, a boy to lead, and a man to hold, and every newcomer into the country has begun his farming by replacing it by a modern iron plough. Yet he often recalls it, and since the implement survives it must possess some good qualities to compensate for its acknowledged wastefulness of labour. In the first place it is very adaptable; it can be mended at home by the ordinary labourer with the tools and material that are always available; without a mould board and armed with a broad flat point it forms a broadsharing plough, one of the best of tools on the chalk soils to get rid of surface weeds and to form a good seed bed, firm below and crumbly above. It is the extreme dryness of the East Kent country which probably accounts for the value attached to this plough; there it is of fundamental importance to maintain the subsoil in a tight, well-packed condition, and the heavy sole of the plough and the trampling of the team of four horses, wasteful as they look upon the light soils, are all of service in consolidating the land. Deep working also is essential in such a climate, and with the Kent plough, a steady, even furrow, seven to eight, or even nine, inches deep can be turned, despite the flint stones which are abundant and add greatly to the difficulty of working with a light iron plough. Similarly on the heavy soils the corresponding foot plough makes very good work; the long mould board with its comparatively rough wooden or wrought-iron surface turns over a nice slice, very

* *i.e.*, a farm cart.

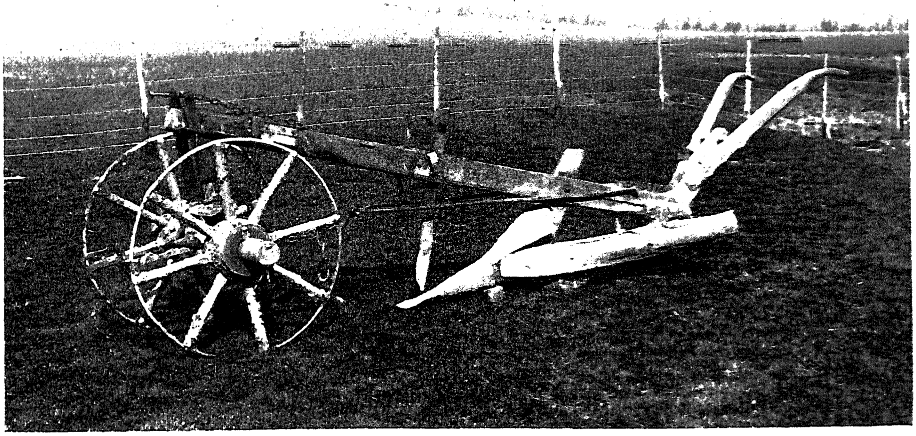


FIG. 5.—KENT PLOUGH, FRONT VIEW.

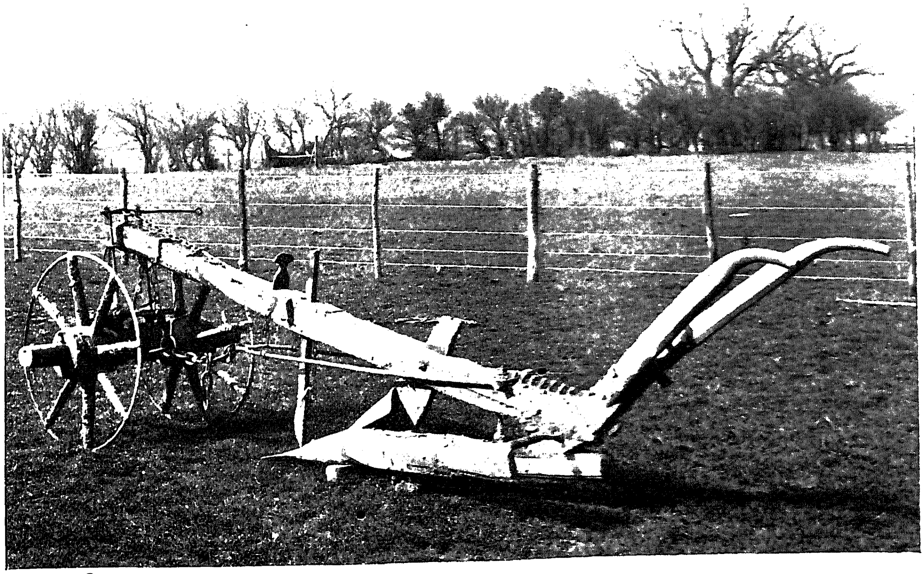


FIG. 6.—KENT PLOUGH, BACK VIEW.

(To face p. 22.)

little smoothed or pasted by the pressure of the mould board. At the present day the Kent plough still maintains its position throughout East Kent, as does the foot plough in the Weald and East Sussex; on the lighter loams and sands of north and Mid-Kent, and in the Isle of Thanet, it has been somewhat replaced by balance or double furrow ploughs—again heavy tools.

In few parts of the country is less attention paid to rotations in the strict sense of the term than in the district under consideration, for though men in a general way keep before them the principle of alternating green or root crops with corn, the variety of crops that are grown, many of which are sold away, and the nearness both of markets and supplies of dung from the large towns, lead to men regulating their cropping by the character of the season and the prospect of the markets. Very great freedom of sale is allowed to farmers, many of whom sell away nearly everything the farm produces; the proximity of London and of a large residential population, as well as the large military camps at Aldershot on the Surrey border, and at Shorncliffe in East Kent, give rise to exceptionally good markets for straw and hay.

The old Kentish rotation was what was known as the round course of wheat, barley, beans, and traces of its influence may still be seen in East Kent customs, as in a common eight-course system, which runs as follows—roots, barley or oats, barley, peas or beans, wheat, seeds, wheat, barley, though there are several variants. In general, however, the foundation of the rotation is the Norfolk four-course—roots, barley, seeds, wheat—the dung going to the wheat and not the roots, but it is rarely followed with any exactitude. A common variation on the better lands is to take oats in the place of the barley, and grow barley as a second white straw crop after the wheat. Another variation is roots (swedes), barley, mangolds, wheat, seeds, oats; this is on chalky land in East Kent, where the seeds are thought to take better on the stale wheat tilth than in barley. Peas and beans are also often introduced before the wheat crop; on the London Clay districts near Epsom potatoes are alternated with the seeds mixture, making an eight years' rotation. Another chalk land rotation is: (1) roots, (2) oats, (3) seeds, (4) wheat, (5) rye and tares, followed by mustard and rape for sheep keep.

Reviewing the practices throughout the district, the following considerations seem to dictate the cropping: swedes are only grown on the lighter land, on the sands and on the chalk where sheep are kept. In the Brick Earth in East Kent and on the better soils derived from the Clay-with-Flints, swedes also answer well, though the land is sometimes too heavy to admit of folding. In such cases the roots are drawn off and consumed on the grass or on the stubbles. On the dry chalky soils of East Kent they form an expensive and not very certain crop, very susceptible to attacks of the turnip flea; they cannot well be grown more frequently than once in five years, and are better for an even longer interval. On the South Downs swedes are not so much grown as might be expected in so purely a sheep country, rape and kohl rabi are preferred by most farmers. Finger-and-toe is troublesome on the sands and on the London Clay throughout both Kent and Surrey. On the stronger soils, and particularly

in the dairy districts of Surrey, swedes are not much grown, but great attention is paid to the mangold crop. The next point to be considered is the seeds mixture; on very few of the soils under consideration will red clover succeed more frequently than once in seven years, hence in alternate courses some substitute must be found for the usual mixture of red clover and rye grass. In East Kent a sainfoin mixture is often used alternately with clover; it yields excellent hay, and a good sheep feed afterwards; a mixture of white clover and trefoil is also sometimes grown for sheep keep. On the stronger soils peas and beans are more commonly alternated with clover, but when the rotation is one of five or six years, a mixture containing alsike and white as well as red clover can be grown every time. Except in the Weald the seeds are rarely left down for more than one year, with the exception of lucerne, and, to a less extent, sainfoin leys.

Lucerne (see Fig. 43) is a staple crop of the arable land of North and East Kent, especially of the Isle of Thanet; elsewhere it is rarely grown on a large scale, though there is some on the chalk in West Sussex. After lucerne has been down for some years it is customary in Thanet to take a succession of corn crops, clean the land with a fallow crop, and sow lucerne or sainfoin again in another straw crop, often without any farmyard manure being used throughout. Lastly, barley does not figure extensively in the rotations (see Fig. 44), except on the Chalk and light sands of East Kent, on the better sandy land in West Surrey, and on the higher gravelly belt of the maritime country of West Sussex. Even on much of the thin chalk lands oats are preferred because barley of high quality cannot be grown after a crop of roots that have been fed off, and yet the land is not strong enough to permit of barley as a second white straw crop. Throughout the Weald and on the London Clay barley is rarely grown.

Catch cropping is general on the lighter soils. On the Thanet Sands and the free working loams of North Kent there is so much market gardening and so little of a regular rotation that the whole system might be regarded as catch cropping. In East Kent mustard, tares, and more rarely rye and trifolium, are sown on the "grattens" or stubbles, to be fed off with sheep before turnips or mangolds. That the practice is not more general is due to the low rainfall of this district; in many seasons the land is too dry after harvest for the catch crop to germinate quickly, and any of the crops that go through the winter and make their growth in the spring—tares, rye, or trifolium—are apt to leave the lands so dry that the subsequent root crop is endangered. Because of the higher rainfall true catch cropping is far more general in the west; in the sandy country near Reigate, and about Godalming, where sheep are extensively bought in for fattening, catch crops are much in favour, as in West Sussex, both on the Greensand and the Chalk. Over all this country, however, the rainfall is six to ten inches more per annum than in East Kent, and the prevalence of catch cropping, as compared with East Kent, is perhaps the best example in the area we are dealing with of a variation in cropping brought about by rainfall.

Cereal Crops.

Wheat.—This crop is still the most important of cereals, and as shown by the map (Fig. 45) it is pretty regularly distributed with the arable land over the whole area, though the most favoured areas are the maritime region in West Sussex and parts of East Kent.

Although so much wheat is still grown the decline in the acreage under this crop during the last generation has been enormous. In 1874, when the maximum area of which we have a record was attained, there were 265,164 acres of wheat in the three counties; in 1904 this had shrunk to 87,315, from which minimum it has since risen a little to 111,529 in 1909. The curves on Fig. 7 show the rate at which this shrinkage has taken place in each of the three counties. Though its cultivation has declined so much, wheat is far from being an unprofitable crop; indeed of late years market gardeners in Surrey and North Kent, where straw is readily saleable, have been finding wheat more remunerative than vegetables. The most widely grown variety at the present day is without doubt "Square Heads' Master," or "Teverson," as it is very generally named. This is found in every district, and is universally approved. After this comes Standard Red (very general), Stand-up-White, and Rivetts—the latter on the Weald and other heavy soils, where it appears to be gaining ground again after having almost disappeared. On the best land, and especially on the loams, two old wheats of better quality are still grown—Golden Drop and Rough Chaff. The latter was particularly a favourite in the coastal districts of East Kent, under the name of Old Hoary, but its tendency to "lodge" and to retain moisture at harvest causes it to be little seen, despite its fine quality, which is probably above that of any other English wheat. "White strawed brown" is a wheat much seen in East Kent; Chiddam is also occasionally grown in the West. High quality wheat was at one time much produced on some of the strong loams in Surrey. The character of the wheat soils is discussed later on p. 140.

Barley.—The barley crop (see Fig. 44) is very locally distributed, being confined to the chalky and sandy loams of East Kent, the Greensand areas of West Surrey and West Sussex, and to the maritime region of Sussex. Elsewhere it is but an occasional crop of poor quality. In the real barley-growing districts, as in the Isle of Thanet, the finer Chevallier varieties, such as Hallet's Pedigree, are almost universally grown. Archer's Stiff Straw is common, but Goldthorpe is only found occasionally on the stiffer lands. Speaking generally, the Kentish malting barleys are sold locally and are of very fine quality though they rarely appear in the open prize lists at the Brewers' Exhibition. The composition of the barley soils will be found on p. 143.

Oats.—Black Tartarian Oats are by far the commonest variety all over the district, and though they are being replaced by some of the newer varieties, like Garton's Abundance and Newmarket, they still predominate. Sussex is distinguished from the other southern and midland counties by the high proportion the acreage under oats bears to that under barley. Usually about as much land is given to barley as to oats, but in Sussex in 1909 oats

constituted 87 per cent. of the spring corn (oats and barley together), whereas in England generally they only formed 57 per cent. The only counties growing any considerable acreage of corn in which the Sussex proportion is exceeded are Cheshire and Lancashire, where oats constituted 98·5 per cent. and 95 per cent. respectively of the spring corn. In the neighbouring county of Kent oats formed 59 per cent. of the total. And as a contrast Norfolk may be instanced where 31·5 per cent. of the spring corn was oats. Winter Oats are not much seen because oats are generally taken after roots folded off by sheep. Sussex Ground Oats form a speciality of the district, being the staple food used by the poultry fatteners in East Sussex. They are made from good heavy oats mixed with barley, in the proportion of ten to one, and ground to a fine meal, almost as smooth as flour, between stones dressed in a special fashion. The whole oat is ground, including the husk, which is removed in the process of making ordinary oatmeal.

Potatoes.

Being within easy reach of London, both for a market and for supplies of dung, potatoes (see Fig. 46) have always been a considerable crop in North Kent and in Surrey, especially on the light loams afforded by the Thanet Sands and the Chalk, and to a much smaller extent on the Greensand. The acreage reached its maximum in the eighties of the last century, when about 17,000 acres in Kent and 7,000 in Surrey were under this crop; since that time, owing to increasing foreign competition, especially among the earlies, the acreage has declined a little. No part of our area can grow really early potatoes to compete with Jersey or Brittany, but the produce of some of the land near the sea on the Isle of Grain and at the end of the Hundred of Hoo comes into the market with the Ayrshire potatoes. At quite a short distance back from the coast line early potatoes cease to be obtainable owing to the damage done by the late frosts. It is, therefore, maincrop varieties that are chiefly grown, and the men who produce them (often Scotch farmers in Surrey) make a speciality of the crop, taking them every third or fourth year with heavy dressings of town dung, up to 30 loads per acre, accompanied by artificials, generally sulphate of ammonia (sometimes in excessive quantities), superphosphate, and potash salts. The dung is usually spread in the drills before planting, except on the London Clay, where it is preferable to plough it in during the autumn. One interesting adaptation of crop to situation is to be seen in the great breadths of potatoes on the steep northern slope of the Downs west of Guildford. The land is easy working and dry, the rainfall is comparatively low, but the cool northern exposure keeps the maincrop varieties growing steadily throughout the summer and ensures a large yield of good quality. For the composition of potato soils in this area, see p. 151.

Root Crops.

Turnips.—As may be seen from the map (Fig. 47) Turnips are somewhat locally distributed in East Kent, on the Greensand in West Surrey and Sussex, and in the Sussex maritime country; but there are very few in Mid and North Kent, the Weald, or on

the South Downs east of Lewes. Practically the distribution of Turnips is that of the winter feeding of sheep; the farms on the Greensand of West Surrey and Sussex depend upon the fattening of sheep brought in from the west country—Hampshires and Dorset Horns, more than on anything else. Turnips first became general in this district in the second half of the 18th century. Boys (1796) says:—

"This plant is more sown with us every year. Thirty years ago hardly one farmer in a hundred grew any, and now there are few, especially in the upland parts, that do not sow some every year." The introduction of the turnip completely changed the character of the husbandry on the chalk by making "folding" profitable.

Mangolds.—The distribution of Mangolds (Fig. 48) is much more general and follows closely the arable land; they are rather thicker than elsewhere in the cow-keeping areas of Surrey and West Sussex, but are comparatively scarce in the Weald and Romney Marsh. In this district both Turnips and Mangolds are always grown on the flat; the ridges dry out too easily.

Grass Land.

Both Kent and Sussex possess considerable areas of natural grass land in the shape of the marshes which stretch along the north and east coasts of Kent, Romney and Pevensey Marshes in the south, and other smaller areas along the Sussex rivers. Most of this land is little above sea level, and has never been under the plough, and though its value varies in a remarkable fashion from field to field, much of it possesses a great reputation for carrying stock. The good Romney Marsh land will carry three ewes per acre through the winter and five or six with their lambs through the summer, while the best of it will fatten ten sheep per acre during the summer. No manure is ever applied to this marsh land and artificial feeding is very rare upon it, so that it has continued for centuries to withstand this great drain upon its resources merely by the inherent fertility of the soil.

The best land is always kept very closely grazed, it loses its value if the grasses are ever allowed to run up, and common opinion holds that the grazing is never again good after the land has once been broken up for arable cultivation. There is, however, good evidence against this opinion; excellent pastures have been re-made by sowing suitable seed mixtures and treating the land liberally.

There is also a considerable amount of very fair grass land on the alluvial flats which border the rivers; some of it which has had much cake and corn fed out upon it has become fattening land almost as good as the Marsh contains. Outside these areas of naturally rich grass the remaining grass land is of no great value. As will be seen from the map (Fig. 49) considerable areas of the South Downs, especially between Beachy Head and the vale of the Arun, are covered with open grass sheep walks, which occur again, though to a much smaller extent, on the North Downs, as for example at Epsom and Banstead. But the short grass of the Downs, though healthy and useful for breeding sheep, possesses no fattening value, and carries a very limited number

of sheep or horned stock. The greatest extent of grass elsewhere is on the Weald: the Weald Clay plain, at one time a good deal under the plough, is now nearly all covered by poor grass of very little value except to run store stock on. The High Weald is also mostly grass and woodland, and the upland meadows carry a thin poor herbage of no quality. In the valleys where there is a greater depth of soil the herbage improves, especially where it has been well managed and highly farmed. The sandy tracts on the Greensand and the Bagshots in West Surrey can hardly be said to be in grass; naturally they carry little more than heath, and even with good farming it is difficult to establish permanent grass of any quality on these soils.

The narrow outcrop of the Gault carries some very fair pasturage which often extends on to the chalk marl terrace adjoining, but the Clay-with-Flints on the top of the North Downs, though largely grazed, is of very poor quality.

Speaking generally, the only rich grass land is on the marshes, the alluvial river meadows and a little of the Gault; elsewhere it is poor and very often starved, much of it being susceptible of considerable improvement by manuring.

Hops.

Hops (see Fig. 50) form by far the most characteristic and specialised crop of the whole district; indeed, excepting that they extend some way into Hampshire from the Surrey district, no more hops are seen in the British Isles until we come to the West Midland area of Worcester, Hereford, and Gloucester. It is only comparatively recently that the cultivation of hops has become restricted and specialised; "hop gardens" as a place-name is common over the South and Midlands of England, and it is only within the last few years that Suffolk, Northampton, &c., have dropped out of the list of hop-producing counties. Though hop-growing did extend widely over the South and Midlands of England, there is little doubt that as an organised industry it began in Kent, being "fetched out of Flanders" in the fifteenth century, and becoming well established in this district within the next hundred years. From the time of their introduction the hop and fruit crops have been grown side by side, and from time to time have replaced one another.

The segregation and specialisation of the crop is still going on; every year the area under hops is shrinking into certain districts where the soil is most suitable and where the cultivation has been tuned up to produce the maximum crops, so that though the acreage shows a considerable falling off of late years (Kent has declined from 44,834 acres in 1885 to 19,636 in 1909) the gross production has by no means experienced the same decline. For example, the hop area in four parishes in East and Mid Kent, selected as typical of the best land, only lost 12·5 per cent. during the three disastrous years 1906-8, whereas four poor parishes in the Weald lost over 20 per cent. in the same period. The decline in hop growing is generally accompanied by an increase in the area under fruit; the same farmer very generally grows both crops, and on the lighter soils of North and Mid Kent there has been a very marked tendency of late years to replace hops by fruit. In Fig. 7 are set out curves showing the acreage under wheat and

hops in each of the three counties, and also of the fruit in Kent. It will be seen that the acreage under fruit in Kent has been rising even more quickly than that under hops has declined, until within the last few years the area under orchards and small fruit have each come to exceed that under hops.

As the map shows, the region of most intense production follows the valley of the Medway and its tributaries from Maidstone to Tonbridge and Goudhurst; the parishes of Goudhurst, Brenchley, and Horsmonden (Weald), Capel, Hunton, Yalding, the Peckhams, Wateringbury, the Farleighs, and others form the very heart of the industry, more than 20 per cent. of the whole area being in hops.

The Mid-Kent hops of the favoured parishes along the Medway from Yalding to Maidstone possess a high reputation, not so great, however, as those grown in the East Kent area, which properly includes the belt of deep loams on the Brick Earth, the Chalk, and the Thanet Sands, stretching along the old Dover Road from a little way outside Rochester through Teynham, Sittingbourne, Faversham, to Canterbury, and then a little further east on the similar soils about Wingham. North-west Kent still grows a good many hops, and the whole Weald of Kent, including even the heavy clay land of the low country is dotted over with small hop gardens, though very many have been grubbed on this unsuitable soil.

In the High Weald and across into Sussex the hops occupy the flat bottoms of the little valleys, in which rich and sheltered positions astonishing crops are often grown. They occur mostly on the stiffer soils of this region; they do not flourish on the sands, as may be seen by the way the hop-land stops short of Ashdown Sands and other lighter soils which occupy the centre and south of the High Weald area. From Kent the hops push a little over the Surrey border into the neighbourhood of Edenbridge and Hartfield, but there the cultivation is rapidly declining. In Surrey, however, there is a distinct centre of hop growing at Farnham; formerly of the very highest repute, the Farnham hops are now little heard of, and many of the most famous old gardens have been grubbed to make way for buildings or gravel pits. The Surrey hop area has shrunk from 2,627 acres in 1885 to 544 acres in 1909; unfortunately, the style of cultivation has also been falling behind, and the hops which remain in the Farnham country are not so well managed as those in East and Mid-Kent. At one time there was a line of hop gardens along the Homesdale which connected this Farnham country with the main Kentish area; the shelf of Upper Greensand, which forms much of the finest hop-land near Farnham, extends along the foot of the scarp of the North Downs through Guildford to Dorking and Reigate and on again to Westerham, and though east of Reigate this particular formation is little in evidence, there is still at the bottom of the narrow valley a bed of good mixed soil, suited to hops. The gardens, however, are now gone, and it is extremely unlikely that they will ever return.

Away in West Sussex, as in the neighbourhood of Midhurst, a few hops are to be found; these are really off-shoots of the Farnham-Hampshire area, and have nothing to do with the hops of the East Sussex Weald.

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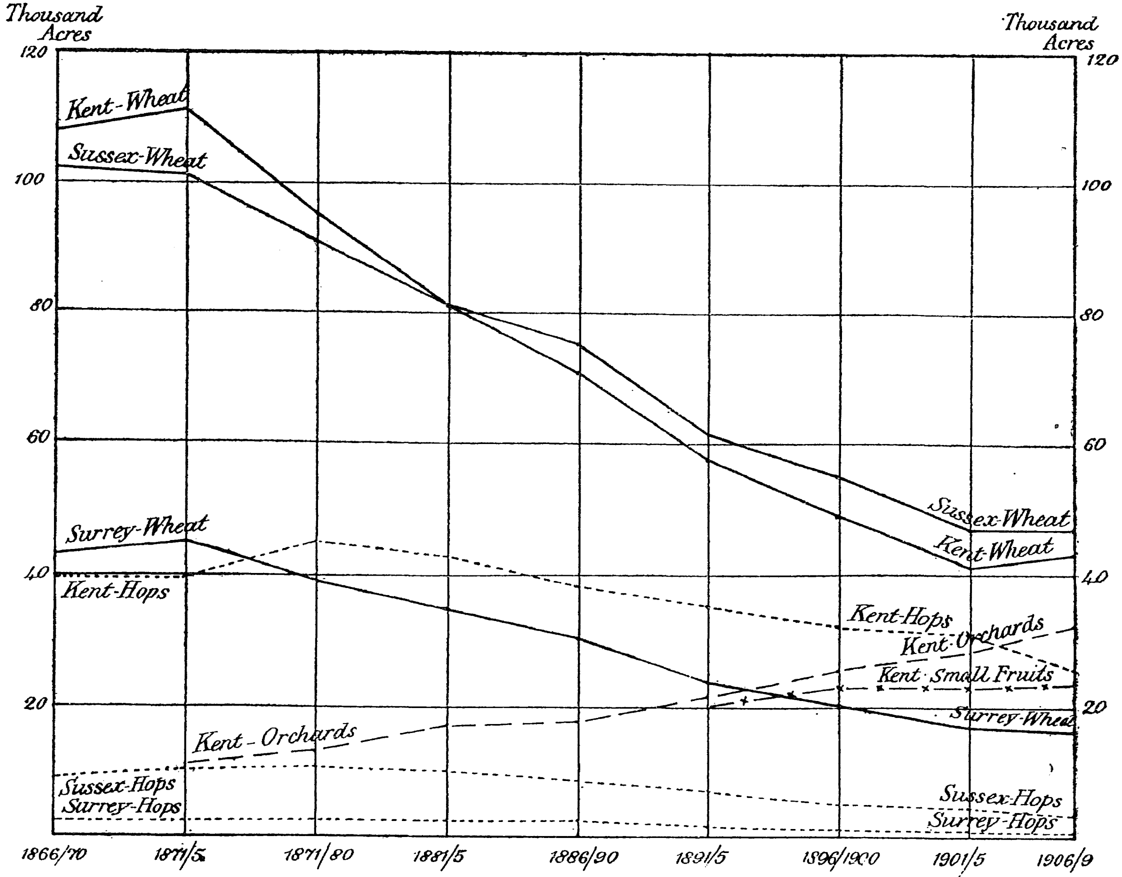


FIG. 7.—DIAGRAM SHOWING CHANGES IN THE AREA UNDER HOPS, FRUIT AND WHEAT, 1866–1909.

The cultivation which is given to the hop-lands shows extreme variations; in backward parts of the Weald small farmers may be found with five to ten acres of hops who grow the hops essentially in the same way as was done when Reginald Scot wrote the first English account of hops, "A perfite platforme of a hoppe garden," in 1576, and whose expenditure up to picking time does not amount to £10 per acre, to which may be added another £10 for picking and drying. On the other hand the large growers of East or Mid-Kent, who subordinate all other farming to their hops, spend between £50 and £60 per acre before their crop is marketed. This great change has come over the industry during the last thirty or forty years through the introduction of intensive manuring, wire and string in the place of the old poles, spraying against blight, and sulphuring against mould. The old plan, still largely followed, was to train hops up poles of chestnut or ash, 12 to 16 feet high, two, three, or four being set to each "hill," as the individual hop plant is called. On the modern system a permanent erection of strong galvanised wire, carried on stout posts 4 inches in diameter at the bottom and 3 inches at the top, is erected over the whole garden, the top wire being at a height of from 12 feet 6 inches to 14 feet 6 inches from the ground. From this top wire every year coir yarn is strung down to the ground, two, three, or four strings being led to each hill; different patterns of lacing are adopted, but they all have this in common that the strings run at a slope of between 50 and 80 degrees with the horizontal, but never vertically. Up each string two or three bines are trained; these reach the top about the end of June, and then fall over to make rather a clustered head at the top. The cluster on the wiring system is never thick, whereas on the old poles there was a great bunch of foliage at the top, within which the hops did not grow, but blight and mould harboured. Despite the prime cost of the wire work, about £30 per acre, and the annual expense of stringing, which is not less than 50*s.* per acre, the outlay is amply repaid by the increased crop and its improved quality. It is doubtful who first introduced the wire and string system, or if the improvement can be credited to any one man, but Mr. Henry Butcher, of Faversham, about 40 years ago did much to introduce the practice into Kent, and his name still remains attached to one of the systems most generally adopted, especially in East Kent.

The typical hop soils are strong, deep, well-drained loams (see p. 145), depth of soil and good physical texture being the most important factors. In East Kent the finest hops are grown on the deep Brick Earths overlying the Chalk, and on the deeper loams belonging to the Chalk itself; the Thanet Sands also grow good hops but are a little too light in texture, while the Clay-with-Flints is rather heavy and generally lies too high. In Mid-Kent the most famous gardens lie on the alluvial soils and Brick Earths of the Medway Valley, or on the deeper loams that have resulted from the downwash of the Lower Greensand. In the Weald and in Sussex the better hops are grown on the alluvial loams and downwash occupying the bottom and lower slopes of the valleys, generally on heavier soils than those appropriated to hops in East or Mid-Kent. In all these districts hops occupy

the valleys, fruit the higher land. In the Farnham district the famous soils are deep loams, either alluvial in Farnham itself, or derived from the Upper or Lower Greensand in the country round.

On the best soils the hop plants lasts for an indefinite period; many of the old gardens are known not to have been replanted for 30 years or more, though a constant renewal of dead hills keeps taking place, to the extent of two or three per cent. of the whole number of hills every year. Though the plant lasts so well it does not retain its full vigour, and replanting every 15 years or so is probably desirable. Replanting on the same soil is perfectly safe, and much of the best land has been in hops as far back as any records extend. On the poorer soils, especially on the heavy Weald soils, the plant does not last so long, ten to fifteen years being the extent of the profitable life of the garden; here, too, it is more desirable to change the location of the hop garden and not replant on the same soil.

The varieties grown vary with the soil, the most highly prized being known as Goldings. The true Golding or Whitebine is a rather late hop characterised by a rounded, much-veined petal and a very delicate aroma. Several sub-varieties of the true Golding exist, the Farnham Whitebine being essentially the same hop. Goldings only flourish on the best soils, elsewhere they are delicate and grow too large a proportion of bine; East Kent and to a somewhat less degree Mid-Kent and Farnham form their true home. The Bramling is a red-bined hop of comparatively modern introduction; it has the Golding petal and much of the Golding flavour, indeed, Bramlings are always sold as Goldings. The Bramling is markedly earlier than the Golding, and is also hardier, so that it is more widely grown and extends into the Weald and Sussex. Cobbs', another recent variety that is sold as a Golding, is a coarser, stronger hop, which grows well in the Weald, though it originated in East Kent, where it is still extensively planted. Some other sorts are also grown as Goldings, though to no great extent. The characteristic hop of the strong soils of the Weald and Sussex is the Fuggle, a hardy vigorous hop with large cones possessing pointed petals and good condition, though lacking the delicate flavour of the Goldings. Universal in the Weald, it is common in Mid-Kent, but is rarely seen in East Kent, on the dry soils of which it does not flourish. Many other old varieties are to be found here and there, especially in the Weald, chiefly coarse-flavoured old varieties approaching the wild form of the hop, such as Colegates and Prolifics; here and there also in the Sussex valleys occurs the Mathon, which is a west-country Golding that seems more adapted to the heavy valley soils than are the Kentish Goldings.

In old times it was the custom to plant one male hop to every hundred hills or so, but for the last 40 to 50 years nothing but female, bearing hops have been planted, the recent investigations at Wye have, however, begun to show that the male hop plays a very important part in the production of a sound and heavy crop, and it is being planted again.

The great pest of the hop crop is the "blight," the attack of the hop aphis, which if left unchecked may develop with in-

Fig. 8.—Old Kilns for Drying Hops.

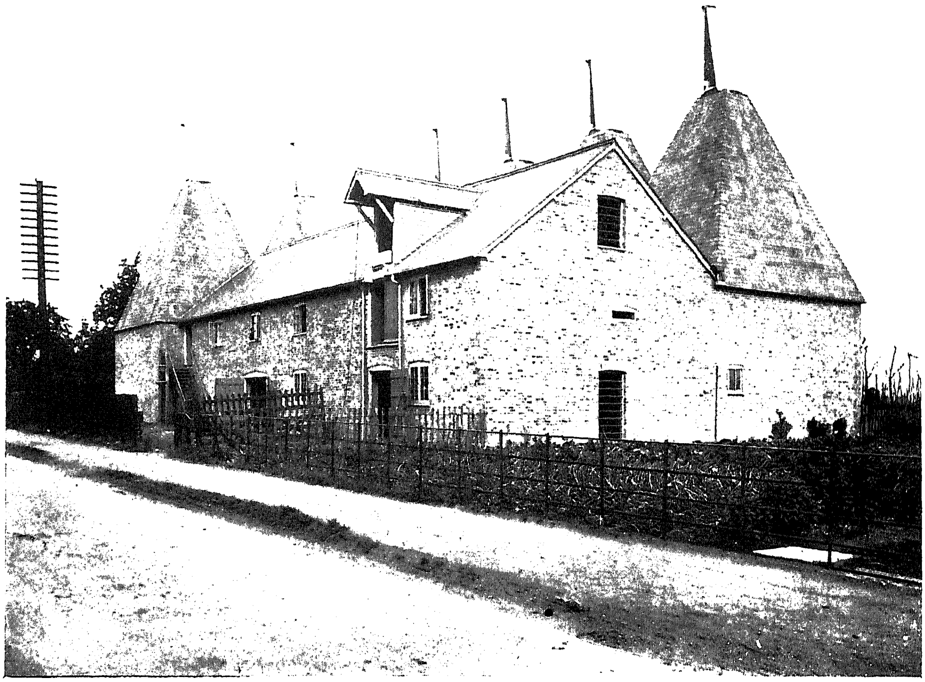


Fig. 9.—A Modern Oasthouse.

(To face p. 33.)

credible rapidity until every leaf is covered with exudations and turns black. A "black blight" used to result in the complete loss of the crop, or perhaps the attack would die down, whereupon the plant would throw out a few fresh laterals and bear a minimum crop. Washing with soft soap and quassia is the universal remedy, but little of it was done prior to the great blight of 1882, after which washing became more and more general. It is now practised by all except the very smallest growers, and it is chiefly carried out by machines, holding about 80 gallons of wash, which are drawn through the alleys by two, three or even four horses, the wheels of the machine actuating a two or three throw pump which distributes up to 500 gallons of wash per acre in a spray reaching well above the heads of the plant. Some of the large growers have adopted a system of underground pipes through which the wash is forced from a common centre, the actual spraying being done by hand from lengths of hose attached to stop cocks distributed about the gardens. In a bad season, such as was experienced in 1905 and in 1909, the hops may require to be washed six times or more.

The second great pest is the hop mildew or "mould," which for the last thirty or forty years has been generally combated by dusting flowers of sulphur over the whole plant by means of a compressed air or "blowing" machine called a sulphurator, drawn through the alleys by a horse. It is not known who introduced the practice of sulphuring, but the example of Messrs. White, of Beltring, Paddock Wood, Kent, did much to popularise the custom.

The kilns or oasts used for drying the hops form the most characteristic feature in the landscape in Kent and East Sussex; the older kilns were round, nowadays they are usually built with square floors (see Figs. 8 and 9).

It has already been stated that the expenditure on an intensive hop farm amounts to about £50 per acre, which is distributed approximately as follows:—

	£	s.	d.
Manures	9	10	0
String and stringing	2	10	0
Cultivations—			
Horse labour	2	0	0
Manual labour	6	0	0
Wash and washing	2	10	0
Sulphuring	0	10	0
Picking—12 cwt. crop...	10	0	0
Drying—12 cwt. crop	3	0	0
Pockets, marketing, &c.—12 cwt. crop ...	2	0	0
Rent, rates, &c....	4	0	0
Depreciation and repair on wire work, lews, &c.	3	0	0
Depreciation of cost of planting	2	0	0
Depreciation on implements	2	0	0
Management	1	0	0
Total	£50	0	0

Hop growing is usually regarded as a highly speculative industry, and, outside of the special areas, is looked on with disfavour by farmers and especially by landlords. It is a crop of violent fluctuations both of yield and of prices; heavy yields and big expenses being apt to be met by a ruinously low price; this has been intensified during the last few years by the bad condition of the brewing industry and some exceptional foreign competition. But most of the agricultural wealth of Kent and Sussex has been made over hops, and the danger comes through the hop grower not allowing himself sufficient reserve for a succession of bad seasons. When big profits are being made the grower is tempted to extend his acreage up to the limit of his available capital or beyond it, so that he cannot stand the depression of the market which a really big crop may cause for several years.

Fruit.

Kent—the garden of England—has been famous for its fruit from the earliest days of which we possess any records concerning agriculture or gardening in England, and in this respect its pre-eminence is not shared by either of its neighbours. As with several other features of Kentish agriculture, Kent probably owes its fruit not only to the magnificent soils along the seaboard but to its constant intercourse with the Continent and particularly with Flanders. In all probability hop growing was brought, ready-made, as it were, from Flanders into Kent, and tradition has it that the first cherry orchards were planted at Teynham from foreign stock, the foreign origin of the cherry being further attested by the prevalence of names of French origin, Bigarreau's, Geans, and so forth.

In his "Worthies of Kent" (1680) Fuller attributes the introduction of fruit growing to refugee Flemings in the middle of the sixteenth century; "before that date we fetched most of our cherries from Flanders and apples from France."

Lambarde relates that Richard Harrys, fruiterer to King Henry the Eighth, obtained "105 acres of good land in Teynham which he divided into ten parcels, and brought plantes beyond the seas and furnished the ground with them." The anonymous N.F., in the "Fruiterer's Secrets" (1684), says that this Teynham orchard "hath been the chief mother of all other orchards for these kindes of fruites. And afore that these graftes were fetched out of France and the Lowe Countries." Drayton, in his Poly-olbion (1613), also writes:—

> "Rich Tenham vndertakes thy closets to suffize,
> When cherries, which wee say, the sommer in doth bring."

Camden writes (1586), (Holland's translation, 1610): "Then saw I Tenham not commended for health, but the parent as it were of all the choice fruit gardens, and orchards of Kent, and the most large and delightfulsome of them all, planted in the time of King Henrie the Eighth by *Rich. Harris* his fruiterer, to the publique good. For 30 parishes thereabout are replenished with Cherie gardens and orchards beautifully disposed in direct lines."

Camden's further remarks would seem to indicate that Kent had long been famous for its fruit growing even in his day, so that probably Harris and the Flemings only improved an industry which had already begun.

Whatever may have been the origin, Kent has always been the cherry-growing county of England, and, though old worn-out cherry gardens are common enough in other counties, nowhere else can be seen the trim orchards in their prime, which are so characteristic of the country between Chatham and Canterbury. Kentish fruit growing has been making great advances both in extent and quality during comparatively recent years; 1871, the earliest year for which returns are available, shows 11,426 acres of orchard in Kent, which had become 33,930 acres in 1909. At the same time, the area under small fruit, which was not returned in 1871, has also been growing and amounted to 25,498 acres in 1909.

A consideration of the map, Fig. 51, which includes both orchards and small fruit, shows that the cultivation of fruit is very definitely located, and is only carried on to any extent on certain special soils (see p. 149). The fruit area forms a band starting out from the south-east of London and following the belt of free-working loams on the Thanet Sands and the Chalk as far as the Medway Valley. The Medway Valley forms the nucleus of another area; a large proportion of the land on the Lower Greensand (Ragstone) on either side of the valley west of Maidstone is in fruit, and here the acreage increases every year on the higher lands at the expense of the hops. When the Medway Valley opens out in the Weald Clay plain, fruit still follows its course on the alluvial soil and even on to the sands and clays of the High Weald, though as soon as the Greensand has been passed the fruit no longer forms the leading feature in the landscape. East of the Medway Valley one of the richest areas of fruit land is formed by the deep loams of the Thanet Sand, Chalk, and Brick Earth, which stretch from Rochester through Sittingbourne to Canterbury, while beyond Canterbury fruit continues to follow the outcrop of the Thanet Sands through Wingham and Wickham round to Ash and Sandwich. In the main, it will be seen that fruit and hops run together; indeed, the same grower is very often deep in both crops; fruit, however, especially small fruit, prefers the lighter soils, and so extends on the Thanet Sands closer to London. In the neighbourhood of London and in North Kent generally, small fruit predominates, large breadths on the Thanet Sands being devoted to strawberries; again, in the Ash and Sandwich district the lightest soils near the top of the series are reserved for strawberries, while the lower more loamy beds are preferred for bush fruit. In Mid-Kent the strawberry is not so prominent, apples and plums with gooseberries below being the most common form of orchard; in this district also, particularly on the tops of the hills where the Ragstone is not very far below the surface, the Filbert and Kentish Cob are extensively grown and flourish exceedingly.

Black currants were once plentiful over the whole area from North Kent downwards, but the ravages of the big bud mite

(*Eriophyes ribis*) have caused the destruction of almost all the old plantations within the last twenty years. In places they are being cautiously replanted with clean stock from France, and in the Weald there are still a few plantations free from disease on the strong soils, on which the black currant flourishes.

East Kent resembles Mid-Kent in its orchards, save that nuts are rarely seen and the cherry plays a leading part instead. Successful cherry growing seems to demand a substratum of chalk; unless the soil is somewhat calcareous and is also naturally well drained the cherry dies or fails before reaching maturity. Speaking generally, the Kentish fruit is grown on tilled land; apples are planted 20 ft. apart, with plums equidistant between them, and nuts, gooseberries, or sometimes currants, are planted in rows below. The apples are generally planted as standards or half-standards upon free stocks, the plums on the Mussel stock; the ground between is kept clean by digging and hoeing, rarely by horse labour. As the bush fruit gets old the apples and plums are often trimmed up to form standards; eventually the bushes are removed and the land is laid down to grass, the plums being taken out in their turn as the apples grow large. Pure tillage orchards of large apples and plums are rarely seen, the old orchards having generally been laid down to grass. A few tillage orchards of dwarf apples, on the Paradise stock, are now to be seen, though not on the Ragstone soils of Mid-Kent, where the dryness of the soil and the proximity of the rock obviate any necessity for a dwarfing stock.

Cherries are generally planted alone at 30 ft. apart, either on tillage land which is kept under ordinary cropping for a few years until the standard trees have established themselves, whereupon the land is sown to grass; or in a hop garden, the hops being grown as usual for two or three years until the cherries have attained some growth. This method, however, is apt to result in a gross weak growth, so that the tree begins to gum and is liable to die back just when it ought to be coming into full bearing.

The typical cherry orchard is always in grass, and the Kentish farmer prides himself on the management of his grass orchards. At its best a grass orchard shows the closest and finest of swards "such that a man may cross dry foot in his slippers," and this is only attained by stocking heavily with sheep, twelve to the acre in summer and six in winter being the ideal spoken of. Of course, such numbers can only be carried by the help of heavy artificial feeding with hay and roots in winter, cake and corn in summer, and in this way the fertility of the soil is maintained. Without doubt the grass exerts a slightly dwarfing effect upon fruit trees, checking their growth as the season advances by drawing heavily on the moderate amount of moisture that is available in that region of comparatively scanty rainfall, and so forcing the tree to form short-jointed fruit-bearing spurs instead of coarse wood. Little pruning is needed in a well-established Kentish orchard beyond the removal of an occasional misplaced branch; and this short-jointed growth is noticeably different from the much greater production of wood in orchards

of corresponding age in the west country. The grass covering is also of particular benefit to the cherry orchards in that it dries the surface soil and brings about the absorption of any ordinary rainfall when the fruit is ripening, at which time a sudden access of moisture to the root is pretty sure to result in the fruit cracking. Kentish orchards are generally clean and well managed; one sees few of the broken-down and worn-out plantations so common in other parts of the country, which only speak eloquently of the greater care that was taken over such matters a hundred years ago. The climate being dry there is not much tendency for moss and lichen to accumulate on the trees; the trees are also kept clean by the regular practice of lime washing, which is being exchanged to an increasing extent nowadays for the more effective caustic winter washes.

Washing with arsenical preparations against caterpillars, and with soft soap and quassia against aphis is very general; Bordeaux mixture and other copper fungicides are now beginning to be used to combat scab, mildew, and other fungoid diseases.

Kentish fruit is usually packed in round bushel and half-bushel baskets, called "sieves" and "half sieves," but though the fruit travels well in these baskets, their appearance is not particularly taking. Indeed, as regards packing and grading, the Kentish fruit grower is much behind his foreign competitors and fails to do justice to his wares. In many cases, especially with cherries, plums, and small fruit, the crop is sold by auction on the trees, the buyer doing the picking and taking all responsibilities of picking and marketing. Cherry orchards not unfrequently fetch as much as £30 per acre for the year's crop.

In Surrey the fruit growing is more distinctly of a suburban and market-gardening type; it is chiefly to be found on the gravels and brick earths of the Thames Valley, and in a few places on the Greensand south of the Chalk, but the acreage has been almost stationary for the last 20 years.

In Sussex the area under fruit is small, and though throughout the High Weald apples and black currants grow well on all but the lighter soils, the orchards are not generally large, and there are no districts specially devoted to fruit. Cider making was at one time regularly practised in the Weald but is rarely seen now, and the true cider apples are not to be found, wildings and the small sweet apples being employed. In fact all the Wealden farms possess small orchards, generally in a very neglected condition. At one or more centres fruit growing now seems to be developing in Sussex, for instance, in the neighbourhood of Worthing. This town has long been the centre of a flourishing industry of cultivation under glass—grapes, tomatoes, cucumbers, and cut flowers being the staple products—and it is estimated that there are about 4,000,000 square feet of glass-houses in this district.

The other great centre for this kind of work in the area under consideration is Swanley Junction in Kent, where it has developed to a very large extent and has become the dominant industry. In the neighbourhood of London, as in the Thames Valley and in the Mitcham district, there is naturally also a good

deal of this cultivation under glass, but the deep chalky loams such as are found at Worthing, Swanley Junction, and Broxbourne in Essex, seem to provide the best soil for the purpose.

Special Crops.

The alluvial soils in North Kent and Romney Marsh, especially in the Hundred of Hoo, Sheppey, and the Sandwich Marshes, were at one time famous for growing seed crops, as turnip and rape seed, radish seed, canary seed, &c., but these crops are now rarely seen. On the arable lands of Romney Marsh a good deal of turnip seed is still grown, and both turnips and radishes for seed may also be seen occasionally in the Hundred of Hoo; mangolds for seed are also grown in both places, the freedom from spring frosts and the dryness of the climate at harvesting being the determining factors in both cases. In the Isle of Thanet lucerne, sainfoin, and clover seed are often harvested, the barley grown there is also much bought as seed corn. Woad used to be an important crop on the poor stiff land of West Kent and on some of the chalky land. Boys (1796) tells us that an acre would produce ½ to 1½ loads, selling at from £4 to £10 per load, but sometimes fetching as much as £21, and at other times being unsaleable. Like madder, however, which also used to be grown, it has long since died out.

On the chalky soils near Mitcham in Surrey, the cultivation of lavender and peppermint for distillation and the production of oil has long been a special industry; of late years, with the encroachment of building in this district, the plantations have been pushed a little further afield in the direction of Carshalton and Beddington for lavender, Cheam and Ewell for mint. There is a lavender plantation at Grove Ferry in Kent, and peppermint is also grown near Burgess Hill in Sussex, and near Orpington in Kent. The English oils, both of peppermint and lavender, are very highly esteemed and command the best price in the markets; the yield per acre is about 12 to 30 lb. of lavender oil, and 8 to 25 lb. of peppermint oil.

Market Gardening.

The proximity of London naturally makes market gardening an important industry in North Kent and in Surrey, in which districts there are considerable areas of light soil eminently suitable for such work.

In Surrey, the gravels and brick earths of the Thames Valley, and the light chalky loams to the west and south-west of the outskirts of the city, form the chief locality for market gardening, most of them being sufficiently near to admit of the grower carting his produce into Covent Garden and bringing back his waggons loaded with dung. Further from London the market gardens extend over the Bagshot Sands almost as far as Woking, but there begin the extensive nursery plantations which form a striking feature on the land up to the boundary of Hampshire. It is in this district that the majority of the fruit-tree stocks used in the country are raised, as also all kinds of

Fig. 10.—Sussex Steer.

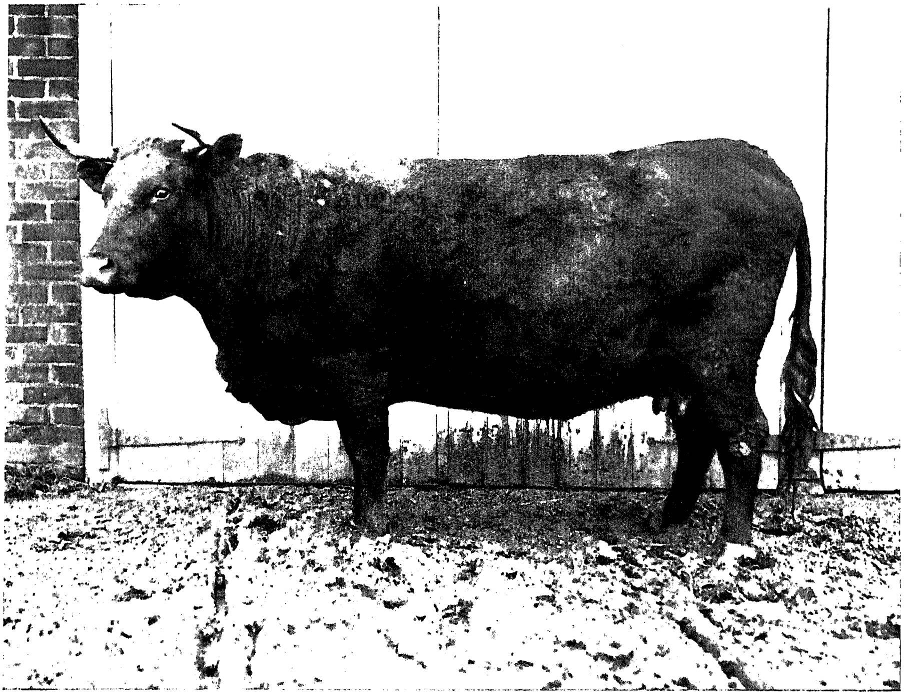


Fig. 11.—Sussex Cow.

(To face p. 39.)

shrubs and ornamental trees, particularly conifers, for private planting and for sale to other nurserymen. The light easy-working soil facilitates the frequent transplantations that are necessary, and promotes the formation of a mass of fibrous roots.

In Kent the market garden area extends further afield; it is located chiefly on the sands of the Thanet formation, the valley gravels, and on the chalk loams as far as the Darenth Valley. It also follows the sea-board as far round as the mouth of the Medway, because London dung can be brought so cheaply by barge into all places in touch with the river. All this market-gardening work is carried out on comparatively poor thin soils but enormous quantities of farmyard manure are employed. The light soil is warm, early, and easily worked at all times, so that by the help of manure plants can be grown very quickly and the land can be utilised for two or more crops each season.

The staple products are cabbages, cauliflowers, broccoli, Brussels sprouts, and greens of all kinds; peas for table, celery, lettuce, onions, carrots, beet, rhubarb, asparagus, are not so much seen. The larger growers also alternate a little with wheat and oats, for the straw of which they obtain a ready market.

Live Stock.

Horses.

No special breed of horses is associated with any of the three counties, and though a number of gentlemen in the district maintain studs, both of light and heavy horses, of considerable repute, nowhere is horse-breeding extensively carried on, nor is it of any particular moment in the farming of the country.

Cattle.

Sussex possesses one of the most characteristic breeds of cattle in the country, the well-known beef cattle, whose characteristic home is the High Weald, from whence they extend both into Kent and Surrey (see Figs. 10 and 11). The fashionable colour is a deep mahogany red with a white tip to the tail and occasionally spots of white on the belly, but light red colours are equally true and admissible. The Sussex cattle are evidently very closely related to the Devons, from which they differ mainly in their greater size and more rapid growth; without doubt they represent a very unmixed strain of the original red cattle introduced by the Anglo-Saxons, which in other parts of the country have segregated into the Devons, the Herefords, and the Lincoln Reds. Owing to the long isolation of the Weald through the badness of the roads in the clay country, the Sussex cattle have remained unmixed with the heavy Continental cattle which contributed to the building up of the Longhorn and the Shorthorn types characteristic of the Midlands and East of England. The Sussex are essentially grazing cattle; they are rarely milked but are allowed to bring up their calves in the open; the young stock are most usually fatted out on the rich alluvial valley pastures, and especially on the Pevensey Marshes. When tied up, however, they fatten with great rapidity into magnificent

butcher's beasts; the records of the Smithfield Show give evidence that Sussex cattle have made greater live weight increases per diem than any other breed.

Up to the nineteenth century the Sussex oxen were employed all over the district for work, being particularly suited to the steep heavy country which prevails throughout the High Weald, where rapid cultivation is impossible. They have been gradually displaced by horses, though they retained their position longer in Sussex than in any other part of the country, and, indeed, at the present day a few yoke are still kept at work. In the neighbourhood of Lewes there is one well-known farm where oxen may still be seen at work, though, on this farm the native Sussex have been exchanged for black Welsh oxen for many years past. The Welsh cattle have retained the deep heavy shoulder, which makes them more suitable for work; the modern Sussex cattle are also ready for the butcher at an earlier age, so that it is more profitable to buy the cheaper Welsh oxen for work. Fig. 13 shows one of the last teams at work in this district.

The manifold excellencies of the Sussex cattle, their rapid growth, their hardiness and thrifty character on comparatively poor land, have never been properly appreciated outside their own district. They are not in many hands, and have mostly been kept in small herds, often handed down for generations from father to son; they have never been taken up and made conspicuous by any breeder of more than local fame, with the result that they have not shared in the cosmopolitan reputation and extension into new counties which have marked the history of the Shorthorn, the Hereford, the Aberdeen-Angus, or even the Devon breed. At the present time, however, they are rising in repute, and an export trade is beginning; the number of pedigree herds is also increasing, especially in Kent.

It is the High Weald country, particularly in Sussex, which essentially forms their breeding area; the store stock are sold to fatten in the marshes or on the arable farms, though the Sussex breeders are far from being able to meet the whole of the demand for store stock, and considerable numbers of Irish Shorthorns and Welsh Runts are also imported. For fattening purposes red Shorthorns crossed by a Sussex bull form favourite stock; and in Surrey north of the Weald and in the arable part of Kent, imported cattle of a Shorthorn type predominate. The map, Fig. 52, shows the summer distribution of cattle, other than milch cows. Their density on the Pevensey marshes should be noticed.

With the extension of the area under permanent grass at the expense of the arable lands, the number of cattle in each of the three counties shows a marked increase during the last generation (see Fig. 12).

Dairying.—Except for the production of milk, dairying does not form a feature in the agriculture of the district, nor has it ever done so. Marshall, in 1798, wrote: "The dairy produce of Kent is merely milk and fresh butter for the higher and middle classes. The lower order of people in the towns and even

in the villages of Kent, as in the courts and alleys of London, eat *Irish butter!* which, with cheese of different descriptions, are sent in immense quantities from London."

With the proximity of London and other large towns, cow-keeping is naturally a standard industry, especially among the many Scotch farmers who have migrated into Surrey and the adjoining counties. The map (Fig. 53) shows that the dairy cattle are most abundant along the outcrop of the London Clay and the lower slopes of the Chalk in Surrey, along the Greensand in Sussex, and more generally along the main lines of railway in Kent and Sussex, with special clusters round the large coast towns. The dairy cattle are nearly all of Shorthorn type, generally showing evidence of a cross, but though Channel Island cattle are common all over the district, and include a few well-known herds, they are almost entirely kept for private supplies.

Sheep.

The district is famous for two very distinct and widely separated breeds of sheeps: the Southdowns, which have their home on open sheep-walks of the South Downs; and the Kent or Romney Marsh Sheep, which are characteristic of the rich pastures from which they take their name.

The Southdown is doubtless in origin a representative of the old short-woolled sheep which extended all over the upland country of England, from which the modern breed has been evolved by a process of selection only, because it is on record that the attempts to introduce either Leicester or Merino blood only resulted in failure. The original Southdown was described by Ellman as " of small size, long and thin in the neck, high on the shoulders, low behind, high on the loins, down on the rumps, the tail set on very low, perpendicular from the hip bones, sharp on the back—the ribs flat, not bowing, narrow in the fore-quarters, but good in the leg though having big bone "; and Arthur Young in 1776 speaks of their " fine coat, procured at the expense of their chine, low fore-end, and rising back-bone." The great improvement in the breed was entered upon in the latter part of the eighteenth century; John Ellman of Glynde did for the Southdown what Bakewell did for the Leicester. He began in 1780, and by 1798 his flocks had such a high reputation that he could sell rams at 150 to 200 guineas, whilst in 1799 he was letting rams out at 100 guineas the season. Most of the modern Southdown flocks trace back to the blood of his stock. About this time also the Southdown began to extend beyond its native country; Mr. Boys of Betteshanger, near Sandwich, introduced it into the hill country of East Kent, and a little later Lord Walsingham and Mr. Jonas Webb of Babraham established it in the Eastern Counties. About the same time the Hampshire Down breed was created by crossing the old Wiltshire Horned sheep with Southdown rams, and later still the Oxford Downs were formed from the Cotswold and the Hampshire with some direct admixture of Southdown blood, which are also used in building up the modern Shropshire and Suffolk breeds.

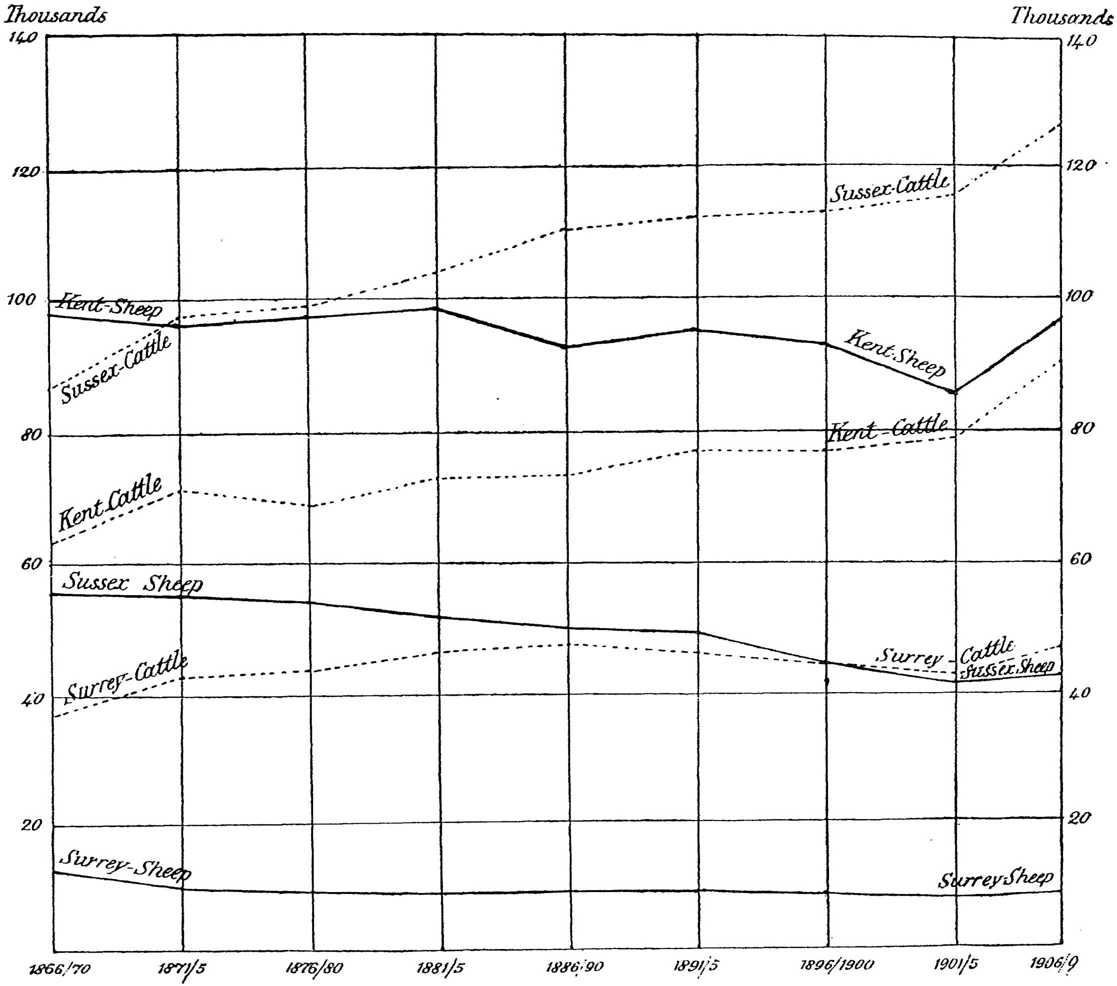


Fig. 12.—Diagram showing changes in Number of Sheep and Cattle, 1866–1909.

Fig. 12.—Diagram showing changes in Number of Sheep and Cattle, 1866–1909.

Fig. 13.—Bullocks Ploughing near Lewes.

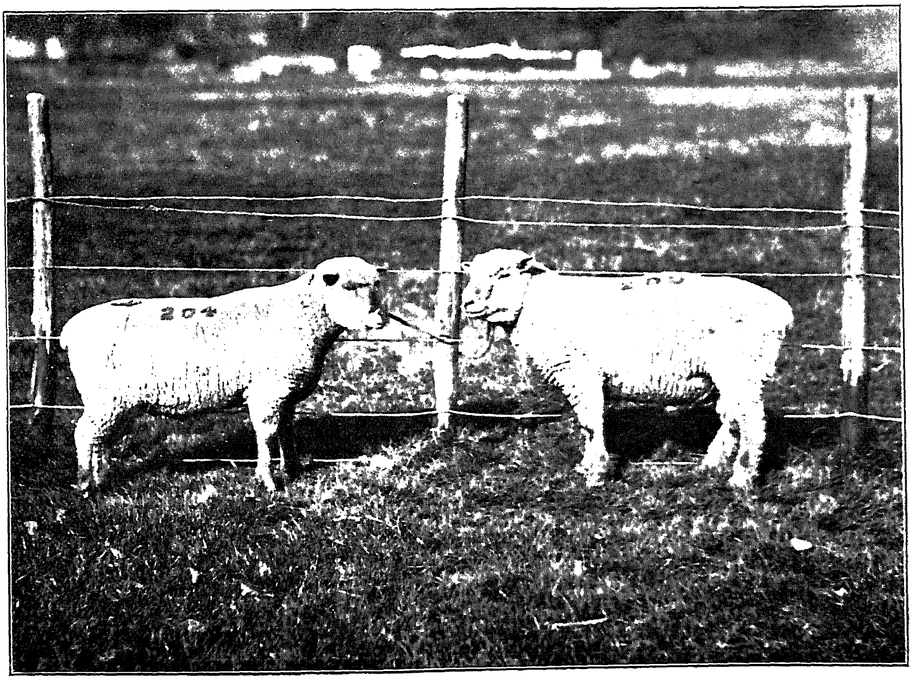


Fig. 14.—Southdown Ram.

(To face p. 42.)

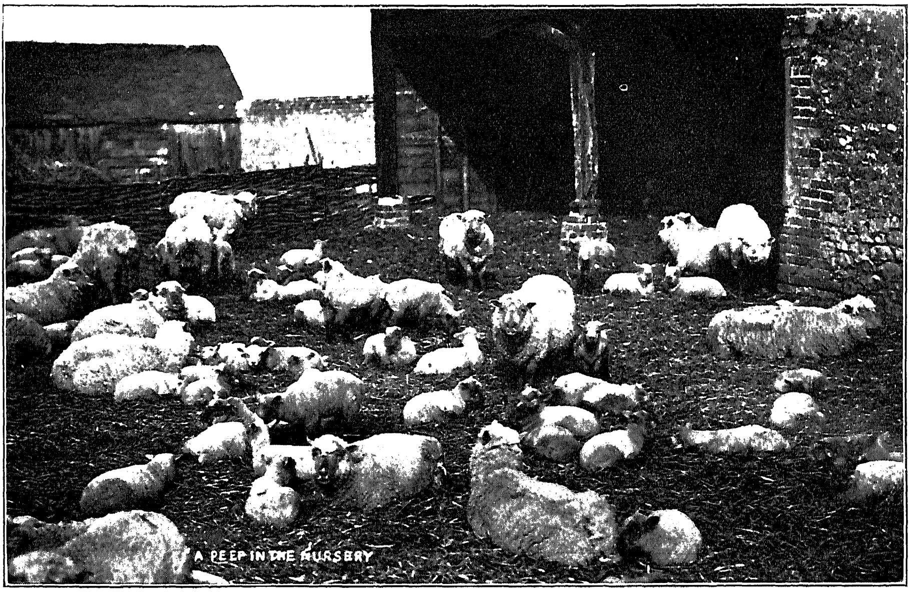


FIG. 15.—SOUTHDOWNS IN THE FOLD.

FIG. 16.—SOUTHDOWN EWES AND LAMBS.

(*To face p.* 43.)

The paucity of accurate records in the eighteenth century makes the real difficulty in tracing the origin and original distribution of our breeds of sheep, but a little before Ellman's time, Gilbert White, in 1773, writes of the sheep of the South Downs: "One thing is very remarkable as to the sheep: from the westward till you get to the river Adur all the flocks have horns, and smooth white faces, and white legs; and a hornless sheep is rarely to be seen: but as soon as you pass that river eastward, and mount Beeding-hill, all the flocks at once become hornless, or, as they call them, poll-sheep; and have moreover black faces with a white tuft of wool on their foreheads, and speckled and spotted legs: so that you would think that the flocks of Laban were pasturing on one side of the stream, and the variegated breed of his son-in-law Jacob were cantoned along on the other. And this diversity holds good respectively on each side from the valley of Bramber and Beeding to the eastward, and westward all the whole length of the downs. If you talk with the shepherds on this subject, they tell you that the case has been so from time immemorial: and smile at your simplicity if you ask them whether the situation of these two different breeds might not be reversed? However, an intelligent friend of mine near Chichester is determined to try the experiment; and has this autumn, at the hazard of being laughed at, introduced a parcel of black-faced hornless rams among his horned western ewes. The black-faced poll-sheep have the shortest legs and the finest wool."

The black-faced poll-sheep no doubt represent the original stock of the Southdowns, while the white-faced horned sheep probably correspond to something like the old Wiltshire breed which we learn from other sources extended at that time into Hampshire.

Figs. 14 and 16 shows a typical Southdown ram and groups of ewes and lambs, taken in early spring when the sheep had been wintered under ordinary farming conditions.

The Southdown is essentially a sheep suitable for folding, and though its typical home is on the open downs of West Sussex, where too it best preserves its special characteristics, it moves down in the winter on to the light arable soils of the Chalk or the maritime region, and on to the shelf of Greensand below the Chalk escarpment on the northern side.

The Southdowns originally lived on the upland grass walks by day and travelled down to be folded on the lower arable land by night, often making several miles along the road twice a day. In Ellman's time the ewes after lambing went on to rye, then in May to seeds ("rye grass is the soundest food we can give"), then in June to winter tares, sown to come in about this time, then to clover or rape. Afterwards, swedes could be given till lambing time, but not after. The present day management is practically the same, except that rape and kale are substituted for swedes.

Lambing takes place in yards or, more generally, in folds which are constructed of thatched wattles at the side of a turnip field, with a straw stack handy. Losses of the ewes after lambing

are often large, because the ewes, which have been living on the grass and travelling several miles a day, are in very low condition. Fig. 15 shows a lambing yard.

Fattened on the arable land the Southdown tegs are usually sold at a little under 12 months old, weighing about 8 stone; the mutton is of great repute, especially the legs. The ewes yield about $4\frac{1}{2}$-5 lb. of wool, which, though short, is of excellent quality.

At the end of the eighteenth century the Weald of Sussex, especially the heathy districts of Ashdown and Tilgate Forests, still possessed a local breed of sheep akin to, and probably identical with, the unimproved Southdown, but these have now disappeared, their places having been taken chiefly by Kents in the East, and to some extent by Southdowns in the West.

Similarly in Surrey upon the North Downs, and particularly upon the heath land in West Surrey, a race of "heath sheep" used to exist, but they have been displaced by Hampshires and Southdowns. One or two flocks are, however, still to be found on the heaths or commons, black or brown faced, thin and high on the leg.

The Kent or Romney Marsh Sheep.—This breed is probably of Flemish origin, and owes its presence in Kent to the same intercourse with Flanders which brought both cherries and hops into the county.

White-faced, with a broad head furnished with a forelock and a pronounced Roman nose, a thick neck, and a close fleece of long semi-lustre wool, the Romney Marsh is a long heavy sheep with powerful bone and strong constitution. The typical sheep have black noses; pink noses and a bald forehead are much disliked. Inferior examples are long in the neck, light in the forequarters with flat sides, high and coarse on the leg, and show a good deal of hair in the fleece, but the breed has been very greatly improved of late years. Figs. 17, 18 and 19 show rams and ewes typical of the breed at the present day. The distinguishing features of the Romney Marsh sheep, which are nowadays taking them all over the world, are their hardiness and capacity to thrive on the roughest and coldest of pastures. Their typical home is Romney Marsh, an open shelterless area exposed to the south-westerly gales from the Channel and the piercing northerly and easterly winds which characterise the spring in that part of the country; there the ewes find their own sustenance throughout the winter, generally without even the help of any hay, and lamb in the open about Easter time. The land is heavily stocked, 2 to 3 sheep per acre in the winter, and 6 to 8 sheep and lambs in the summer; it is low-lying and, though the drainage is improved, it is still much subject to epizootic and other diseases, so that sheep of less hardy breeds never thrive. The Romney Marsh ewes are also good foragers; they will scrape away the snow to find their keep, and are noticeable as scattering to graze singly about the field.

There is no record of the original introduction of this sheep into Romney Marsh; its Flemish origin can only be surmised from its resemblance to the sheep in Flanders and its unlikeness to the down and heath sheep by which it was surrounded,

FIG. 17.—ROMNEY MARSH EWES AND LAMBS.

FIG. 18.—ROMNEY MARSH EWES.

(To face p. 44.)

FIG. 19.—ROMNEY MARSH RAM.

(*To face p.* 45.)

but the case is strengthened by the admitted derivation of much of the Kentish farming from Continental models. At any rate when it first emerged into distinct notice towards the close of the eighteenth century it was a coarse, hardy, long-woolled sheep well esteemed by the butchers despite the inferior quality of the mutton. Attempts were made to improve the race by the introduction of Leicester rams from Bakewell, and though this innovation was stoutly resisted by the local graziers, without doubt the Leicester has left its mark in producing a finer quality of sheep of more rapid growth, without impairing the hardiness of the local breed. Other crosses, with Lincoln and with Cotswold rams, were tried towards the middle of the nineteenth century, but the progeny proved to be unsuited to the hard winter and early spring conditions of Romney Marsh, and all traces of the cross were soon eliminated. The man generally associated with these early improvements by cross-breeding and selection was Mr. Wall of Ashford, but the breed still remained in a very rough condition until comparatively recently, the Marsh sheep being somewhat different in type from those of the uplands of East Kent. Mr. Gourd of Sittingbourne was one of the earlier improvers of the breed in East Kent, and his stock are still spoken of at the present time.

During the last generation, however, a great advance in quality and uniformity has been seen. Towards this improvement the late Henry Rigden of Lyminge and T. Powell of Lenham did much, and their rams form the foundation of most of the best flocks of the present day. Latterly a considerable export trade has grown up in the Romney Marsh sheep, especially to Argentina and New Zealand, where, because of their hardiness and activity, their large carcass and heavy fleece, they are greatly valued for crossing with the Merino. The ewes spend the winter in their typical home—Romney Marsh and the other marshes along the Kent coast—and do not lamb until the second week in April, so that there shall be a good growth of grass, the only food available, by the time the lambs begin to eat for themselves and be weaned. It is customary to shear the lambs at the same time as the ewes, the common idea being that they will then do better and fatten more quickly. If the lambs are to be sold in August, they are shorn before the ewes so that the extra growth of wool may improve their appearance. On these rich pastures the lambs pass the summer, but as they are unable to winter in the Marsh, both from lack of food and because they are liable to various epizootic diseases which the ewes resist, at the end of July or in August they are moved off to the uplands of Kent and Sussex and even as far as Surrey. Farmers near at hand move them by road, but in general special trains are requisitioned, and for a month or so the countryside is noisy with the flocks of bleating lambs moving off to their winter homes.

Extensive sales of the lambs are held on the outskirts of the Marsh towards the end of August, but very generally the Marsh flock owner puts his lambs out to keep on grass land that has been hayed and had no sheep on it, paying 4*s.* to 5*s.* per score per week, and brings them back to the Marsh

in April. Sometimes they are put on turnips, the flock owner finding cake and corn, but more generally they are wintered on the grass without any artificial food, and the survivors, for 10-20 per cent. die, come back to the Marsh in deplorable condition, many of them being mere bags of skin and bone. It is a bad system but pays, as so much bad farming can be made to pay, because all expenditure has been cut down to a minimum and a certain amount of saleable stuff has been drained from the land without any cost. Nothing better, however, is available for the vast majority of the lambs which have to be taken off the Marsh, and the graziers further justify the system by the consideration that the winter hardships only weed out the weakly lambs which would prove bad doers and unprofitable in any case. It is also found that lambs who have been on turnips during the winter do badly when they return to the Marsh.

Many of the better Marsh farmers possess upland farms of their own, where the better lambs are fattened out on the turnips with cake and corn, and the others are kept in condition on the grass land with a little hay, so that they go back to the Marsh ready to take advantage of the grass and fatten quickly. Speaking generally, the treatment is improving; rather more is paid for the wintering of the tegs, and both they and the ewes are now often given a little hay, pea straw, &c., in the severe weather.

The Romney Marsh sheep are thus sold to a limited extent as tegs fattened on turnips throughout the winter, but most typically as tegs about 18 months old fattened on the grass in the Marsh in their second summer. In the latter case they usually weigh about 12 stone and yield good mutton, though not of the highest quality, the sheep being often too big and fat for the present taste. The ewes clip from 6 to 8 lbs. of wool of fine quality, though it usually sells at lower prices than Southdown wool. The old custom was to fatten the tegs in their second summer, but with the modern demand for smaller mutton, graziers fatten as many as possible in their first season. The Romney Marsh sheep are at the present day generally kept throughout the Weald of Sussex and Kent, and also on the chalk uplands of East and Mid-Kent, only a few Southdown flocks being found east and south of Canterbury. In these districts their management is similar to that described above, though they are mated so as to lamb a fortnight or three weeks earlier, and winter fattening on the arable land is naturally more general. On the uplands a good deal of cross-breeding is done; Kent ewes crossed by a Southdown ram are found to make excellent compact thriftly lambs which grow more quickly and fatten earlier than the pure-bred Kents.

The map (Fig. 54) showing the distribution of sheep illustrates very clearly the density of the breeding flocks. The heavy shading in Romney Marsh, the country round Ashford in Kent, and the East Kent Marshes shows the breeding and fattening grounds of the Romney Marsh flocks; the Southdowns are also seen to be collected on the hill country of that name; while there are a considerable number of breeding sheep all along the North Downs and the Weald.

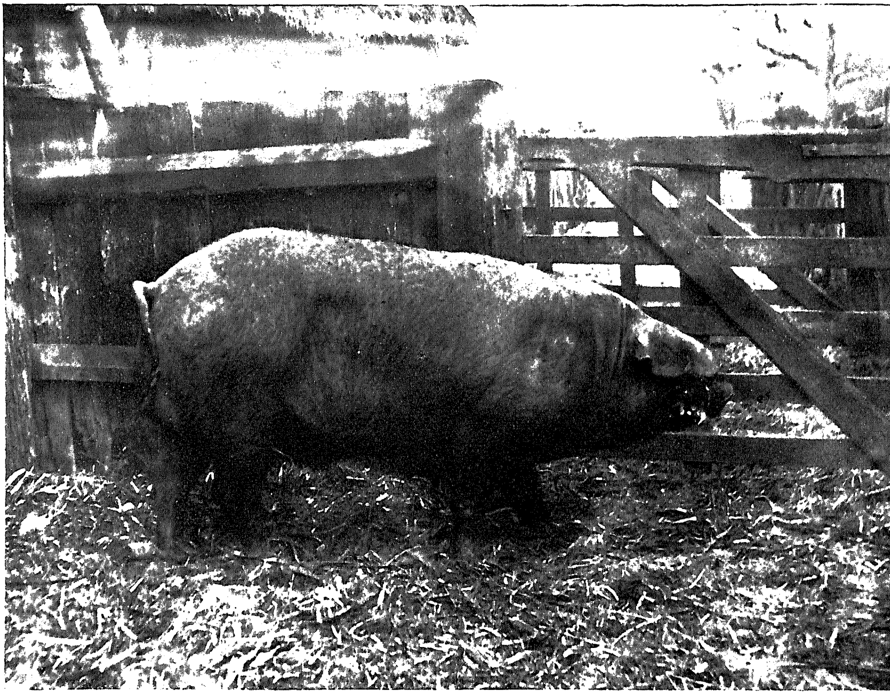


FIG. 20.—KENT BOAR.

FIG. 21.—KENT PIGS.

(*To face p.* 47.)

The map is, however, compiled from returns taken in June, so that it indicates only breeding and summer fattening sheep; had the returns been made up in the winter the distribution would have been very different. At that time not only would the Marsh lambs have come up on to the uplands, but the Southdowns would be distributed over the arable land on the Chalk and the Greensand in Sussex, and large numbers both of Southdowns and of tegs bought from Hampshire, Dorset, and further west would be found on the light Lower Greensand soils of West Surrey. The country round Midhurst, and particularly the light Greensand area in the neighbourhood of Godalming and south of Guildford, depends essentially upon sheep, which in the main are not bred there but are bought in and folded upon the turnips and catch crops. In the autumn special trains are run once a week to hurry the store sheep from the west country to the fairs in this district. Sheep cannot be kept in summer on the Greensand, hence the animals are fattened and sold off during the winter, and are all disposed of by Easter. The Chalk, however, will carry them, since it is cooler in summer. According to Marshall it was in Kent that the custom originated of feeding cake to sheep that are fattening upon the turnips; in his report on the agriculture of the country round Maidstone, he writes:—

"In the *fatting* of sheep, the only peculiarity of practice which struck me in the district under view, was that of employing *oil cake*, as an ordinary material or food, of fatting sheep; a practice which, I understand, has been followed for half a century. It is given to them in covered troughs (some of them ingeniously constructed) usually in the field, either with a full bite of grass or with hay; also with turnips and perhaps an addition of hay. In either case it is a practice well calculated to forward the condition of the sheep and to improve the land on which it is used."

The statistics (see Fig. 12) show that, unlike cattle, sheep have been losing numbers somewhat during the last 30 years; in Kent the sheep have fallen from over a million in 1868 to 1,013,228 in 1909; in Sussex from 602,000 to 444,976, in Surrey from 128,000 to 69,648. The lowest point, however, was reached in 1903, since which period the sheep in Kent have increased by two hundred thousand. Surrey shows the greatest relative decline, but the figures are less significant, because the county has always fattened rather than bred sheep, and this to an increasing degree of late years.

Pigs.

In no part of our area does the breeding of pigs form a very important feature of the agriculture; there is little or no bacon curing, and what pigs are raised are sold in the main for local consumption.

In Surrey the Berkshire is naturally the predominant pig, but in East Kent and in Sussex the old English long black pig with drooping ears is still common. Figs. 20, 21 and 22 show typical animals from herds in each county which have long been kept pure. Several herds exist where the strain has been kept pure and the animals true to type, and as the good qualities of this

excellent bacon pig have recently been recognised by the formation of a Large Black Pig herd book, it is to be hoped that it will become more general. None of the old unmixed Kent or Sussex herds have, however, been registered, so it is probable that they will die out as a separate type and become merged in the general Large Black breed.

Poultry.

Surrey and Sussex have long been famous for their poultry; Surrey capons are proverbial and were derived either from that typical county breed, the Dorking, one of the most distinct of the purely English breeds, or from the characteristic farmer's bird, the old Sussex fowl, a composite breed which has latterly been fixed as a show breed and bred to type. One particular part of Sussex, the country round Heathfield, has during the last generation become the home of a prosperous industry, the fattening of table fowls for the London market, and it is estimated that 1,200 tons of dead birds ready for the market were despatched from this district in 1906.

The fatteners, or "crammers" as they are called, rarely breed the birds themselves; they are bought up from the farmers and cottagers for considerable distances at about three to four months old, and are then confined and heavily fed by hand, chiefly with ground oats. At first the feeding is done in the ordinary way, but the last fortnight or three weeks they are crammed twice a day, a mixture of meal and water being forced into the crop of the bird through a rubber tube by a machine controlled by the foot of the operator.

All over the area poultry-keeping has visibly made great advances during the last 10 or 20 years. In many cases farmers are taking to keeping poultry with the other stock in their grass fields, and this is particularly true of the smaller men. These counties too are favourite haunts of poultry farmers pure and simple, too often amateurs out of the towns whose experiences are short and disastrous.

Forestry.

The counties of Kent, Surrey, and Sussex possess a considerable area of Woodland, amounting in all to 280,235 acres in 1905, or about 12 per cent. of the total land area.

Distribution of Woodlands.—The map (Fig. 55) shows that while the woods are distributed pretty generally over the whole area, because of the parks and ornamental woods which are so general in these favoured residential areas, there are certain special woodland districts representing the ancient forests whose names are still preserved in several places. In the main these forest areas occupy either land at a considerable elevation, over 400 feet above sea level, or land that is either too heavy or too light to be very profitable under cultivation. For example, the ridge of the North Downs at its highest elevation near the escarpment is generally wooded; at such an elevation the Clay-with-Flints which there covers the Chalk is difficult to work and

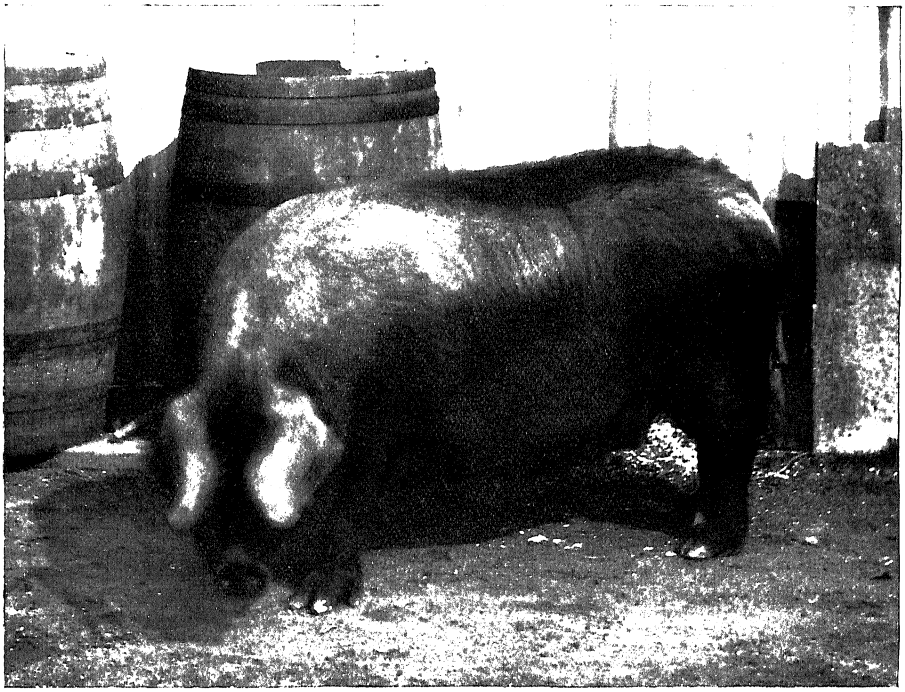


FIG. 22.—SUSSEX SOW.

(*To face p.* 49.)

yields poor returns in crops. The South Downs from Beachy Head to the valley of the Arun are generally bare, but a great change then sets in, the more elevated parts of their western extension in Sussex being almost entirely covered with woods.

A considerable part of the Lower Greensand ridge from Maidstone westwards is also occupied by woods; in Surrey, particularly west of Leith Hill, and round into West Sussex the higher portions of this ridge have generally been planted with conifers.

As to the High Weald, the ancient forest of Anderida, which in later times became the "Forests of Worth and Ashdown," its popular name to-day of the "Forest Ridge" shows the prevalence of woodland. The Weald Clay looks more wooded than it really is because of the smallness of the enclosures and the abundance of hedgerow timber, yet on it there are one or two extensive areas of oak plantations.

On the London Clay again there are some extensive plantations, as in the Forest of Blean and the neighbouring woodlands south and east of Whitstable. On the Gault Clay there is one woodland area, the Crown Forest of Alice and Alder Holt on the extreme western boundary of Surrey. On the Bagshot Sands also in West Surrey there are great woodland areas adjacent to Windsor Forest, some parts of which extend into Surrey.

Timber Trees.—Of the native trees that are grown for timber, oak and beech occupy the most prominent places: oak, the "Sussex weed," is the leading tree all over the heavier soils of the High Weald, on the Weald Clay, on the high land of the North Downs and on the Gault and London Clays. It is everywhere reputed to yield timber of high quality, though it is too generally grown as standards over copse-wood (or as "coppice with standards") to produce the tall clean stems which are the most valuable.

The beech is the characteristic tree of the South Downs, and though single trees and even beech woods are common enough on the North Downs, nowhere else are to be found the magnificent beech forests which occur upon the Chalk west of Arundel.

The ash is also extensively grown, but mostly in the west where the rainfall is heavier, and commonly only on the wetter soils where oak or chestnut will not thrive. It is rarely grown for timber, but is mostly cut over for poles and staves, walking sticks, and other small articles. The other deciduous tree which has been very extensively planted on all the lighter soils in the eastern area of the High Weald, on the Greensand Ridge and on the North Downs in Kent, is the Sweet Chestnut. This provides the most durable poles for the hop grower, and as long as the old system of planting hops with two or three poles to each hill was in vogue, a great acreage of chestnut was required to supply the poles, especially before the general use of creosote. With the introduction of the string and wire system fewer but much heavier poles are needed, and though chestnut has been a great deal used, much larch, both home-grown and imported, has been employed, after being

heavily impregnated with creosote to ensure its durability. In East Kent and in West Surrey a certain amount of alder is grown in the wetter bottoms for sale to the powder mills.

Of the conifers larch has been very generally planted on all soils, and the slowly-grown larch poles from the Chalk have a considerable reputation for their strength and toughness. Scotch fir has been also extensively planted and spreads naturally over the barren heaths of the Lower Greensand and Bagshot formations in West Surrey, forming there the most characteristic tree. It has also been extensively planted in the High Weald. In Eridge Park, for example, some very fine plantations of pure Scotch fir may be seen; in the area under consideration the quality of its timber is generally reputed as good.

No other kind of tree is of much economic importance in the South-East of England; elms are of course common in the parks and in the hedgerows on the cultivated soils, and there are some plantations of Douglas fir and spruce, the former growing very rapidly on the light soils if provided with shelter. Among the underwood hornbeam and birch are common, both in the High Weald plantations and on the North Downs; the yew is also a very characteristic tree of the Chalk though of no value for timber. Speaking generally, however, only the Beech and the larch on Chalk, the oak and the ash on the heavier soils, and Spanish chestnut, Scotch fir, and larch on the sands, yield any timber.

Underwood.—In the main the chief woodland crop in the South-East of England has always been underwood, the plantations being cut over on a rotation of from 8 to 16 years. The underwood supplies in the first place hop poles, but wattle hurdles are very generally made, and the smaller stuff is also split for barrel hoops, the brush being sold as faggots for burning, pea-sticks, and the like. Some hazel and ash are used for making walking sticks, and the best ash is also used for various bentwood purposes, as in making tennis racquets. At one time charcoal burning was very general within reach of the hop districts, the hop driers in the Weald and Sussex preferring charcoal for their small kilns, while some is used in all districts; the "colyers" however are dying out, and only a few are still to be found at work in the High Weald and on the North Downs in East Kent. Figs. 23, 24 and 25 show a charcoal burner at work on a farm in the Sussex Weald; on one hearth the burning is complete, and the charcoal is cooling down, on the other the wood has just been stacked and is ready for covering with soil and ashes. The great shrinkage in bulk should be noticed.

Of recent years, however, underwood has become entirely unprofitable; whereas the cut used to sell at as much as £40 an acre, £2 to £5 only has been obtainable lately. This has been mainly due to the change in the system of training hops and to the depression which has overtaken that industry: 16 ft. hop poles used to sell in the wood at 18s. per 100, but are not worth nowadays more than 12s.; even chestnut poles for wire-work 18 feet long, 4 inches in diameter at the butt end and 3 inches at the top, often weighing half a

FIG. 23.—CHARCOAL-BURNING; MAKING THE HEAP.

FIG. 24.—CHARCOAL-BURNING; THE END OF THE PROCESS.

(To face p. 50.)

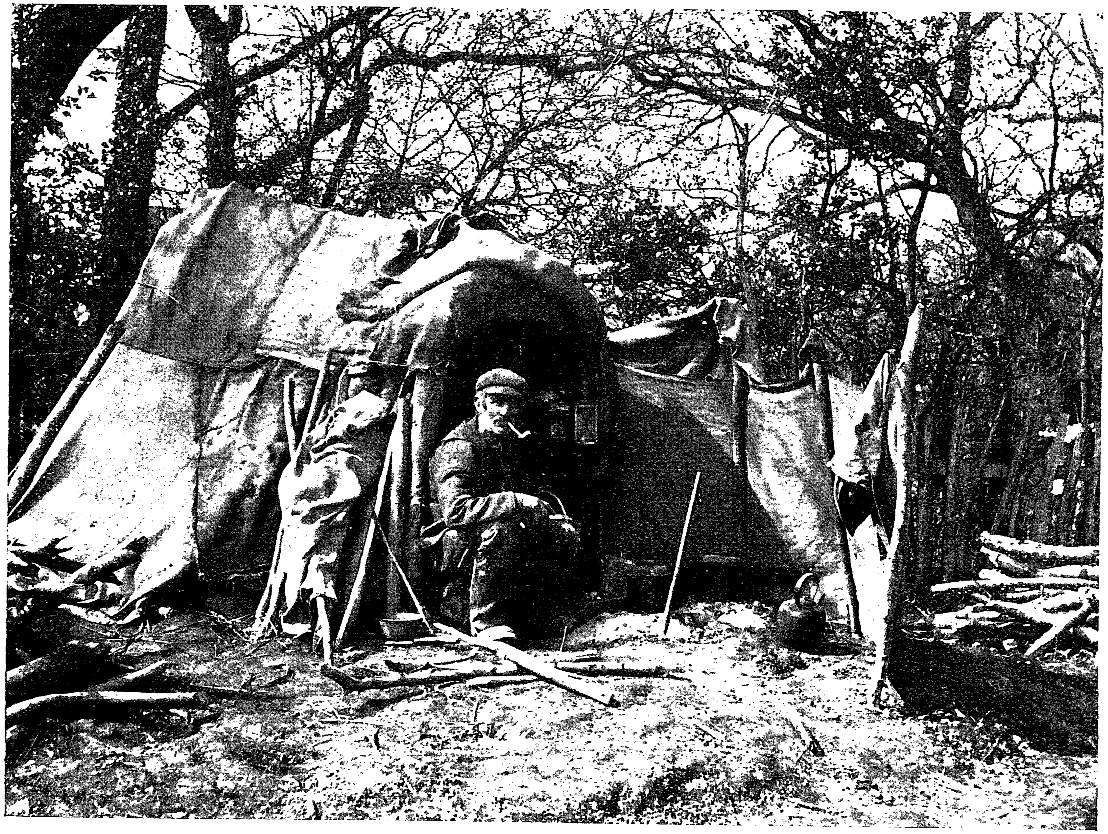


FIG. 25.—CHARCOAL-BURNER'S HUT.

(To face p. 50.)

hundredweight each when trimmed and stripped, have been bought for the last year or two at 20s. per 100 in the wood. With this collapse in the value of underwood, which is likely to be permanent, increased attention is beginning to be paid to timber trees, and a good many landowners are taking steps to convert their underwood into high forest. It cannot be said, however, that within the area dealt with there are any good examples of systematic farming for timber on a definite plan. The planting has been casual and irregular, the thinning has been unsystematic, and the felling has also been conducted on a somewhat haphazard system. If we except the Crown forest of Alice Holt, the great beech woods of the West Sussex Downs, and one or two oak areas in the High Weald, there has been no regular trade in timber. In general the timber cut has been used for estate purposes or sold locally for gate-making and other objects; the best beech goes into the High Wycombe district for chair-making, but there are no industries within the district depending upon the local timber supply. More perhaps than in most part of England the character, distribution, and management of the woodlands have been determined by considerations of ornament, of shelter to the cultivated land, and above all of game.

CHAPTER III.

SOILS.

METHODS OF ANALYSIS.

The analytical work upon the soils that have been examined in the course of this survey, the details of which are given in Chap. VI., is of a twofold nature: it consists of both chemical and mechanical determinations of the constituents of the soil. The mechanical analysis deals with the structure of the soil, with the *size*, as distinct from the *chemical composition*, of the particles making up the soil. Every soil is built up of irregular but roughly rounded stony particles of all sizes. When a sand is examined the particles are observed to be comparatively large, and they can be seen and handled with ease; in a clay, on the other hand, the particles are much too small to be seen, and even on rubbing the clay in a wet state between the fingers the separate particles of which it is built up are too small to be perceptible.

The Mechanical Analysis.—In making a mechanical analysis of a soil the particles are simply graded and eventually sorted into a series of weighed fractions, each of which contains only material falling between certain given limits of size. The grading is carried out by means of sieves for some of the coarser grades, but in the main by a process of sedimentation from water.* The particular grades adopted in this report are as follows:—The soil is first of all put through a sieve which takes out everything larger than 3 mm. (⅛ inch) in diameter, such material being classed as gravel and stones. It is the fine earth passing through the sieve which is used for analysis, and from it is next separated the "fine gravel" coarser than 1 mm. (1/25 inch) in diameter, and then the "coarse sand," the particles of which are more than 0·2 mm. (1/125 inch in diameter). This is as far as sieves can be used; by means of water the remainder is divided into four more fractions—"fine sand," "silt," "fine silt," and "clay"—the last being the excessively fine material which is barely discernible as separate particles under the highest powers of the microscope, since they are all less than 1/12,500 inch in diameter and indeed run down to molecular dimensions. Thus the following series of fractions are obtained:—

—	Maximum Diameter.	Minimum Diameter.
Stones and Gravel	—	Greater than 3 mm. (1/8 inch)
Fine Gravel	3 mm.	1 ,, (1/25 ,,)
Coarse Sand	1 ,,	·2 ,, (1/125 ,,)
Fine Sand	·2 ,,	·05 ,, (1/500 ,,)
Silt	·05 ,,	·01 ,, (1/2,500 ,,)
Fine Silt	·01 ,,	·005 ,, (1/5,000 ,,)
Clay	Less than ·002 mm. (1/12,500 inch).	

* Jour. Agric. Sci., 1905-6, I., p. 470.

It must be understood that the above terms are used in the limited sense defined by the dimensions given; soils consist of a mixture of particles of all grades, a sand will contain silts and clay, and a clay soil will rarely contain as much as 50 per cent. of the true clay that is defined as material less than 0·002 mm. in diameter.

A mechanical analysis really defines and gives exactitude to the ordinary practical man's classification of soils into sands, loams and clays. Not only are such terms inadequate to describe all the varieties of soil met with in practice, but different workers would by no means agree in their use of the terms; by the mechanical analysis we get a series of figures on which a definite classification can be based. But it should be understood that the practical man's opinion of a soil is really based upon the sizes of the particles which are revealed by the mechanical analysis; it is the relative predominance of the coarser or finer grades of particles that determines how a soil will work, how quickly it will dry after rain, to what extent it will withstand drought, in fact most of its behaviour towards water. Two considerations will suffice to make this latter statement evident: the size of the particles will determine the size of the spaces between them, and the water will drain through the soil quickly or slowly, according as these spaces are large or small. Again, the smaller the particles the more surface they will possess for a given weight of soil, and as the water retained by the soil after the drainage has ceased is in the main that which clings to the wetted surface of the particles, the finer-grained the soil is the more water it will retain. The total surface possessed by the particles making up a soil determines other properties, such as its power of retaining certain manures, and particularly its power of lifting subsoil water to the surface during a drought to replace losses by evaporation or crop—its capillarity.

The Chemical Analysis.—In the chemical analysis the first significant figure that is given is the "loss on ignition," the proportion of the material which can be burnt out of the soil at a low red heat. It consists in the main of the organic matter of the soil, the humus or dark decomposed matter which has been derived from the roots and stubble of the previous crops or from farmyard manure, but it also includes a certain amount of water that was combined with the clay. The organic matter of the soil is the chief storehouse of plant food, and it also has a very marked effect upon the physical quality of the soil. Without a good store of humus it is almost impossible to get a clay soil to work properly or to come down to a fine texture; humus also gives sandy soils binding power, and is a great factor in retaining water.

The nitrogen in the organic matter, which is determined separately, is the most important constituent of the plant food in the soil, though the fertility of the soil depends not only upon the total nitrogen in the soil, but also on the rate at which it can be brought into a combination utilisable by the plant.

The other two constituents of plant food which are of great importance are the phosphoric acid and the potash. The latter is always most abundant in a clay soil; in fact its amount bears a

pretty constant relationship to the amount of clay as determined by the mechanical analysis. As both phosphoric acid and potash are present in all soils in comparatively enormous quantities but in compounds which are too insoluble to reach the plant, further determinations are made of the amount soluble in a 1 per cent. solution of citric acid. This determines what has been called the "available" phosphoric acid and potash, that which is easily soluble and may be taken up by the plant if the other conditions of growth are favourable.

Among the most important constituents of the soil determined by a chemical analysis is the carbonate of lime—not merely the total amount of lime, however combined, but the amount present as carbonate, which will serve as a base to prevent the soil getting acid. Soils devoid of carbonate of lime are never fertile, because without it the plant food of the soil cannot readily be brought into a condition available for the plant, and many of the most important bacterial actions in the soil are dependent on the presence of a base like carbonate of lime; certain diseases also, such as "club root" or "finger-and-toe" among turnips and cabbages, are prevalent on soils lacking in carbonate of lime.

The other determinations which are given are mainly of scientific interest, and cannot so readily be interpreted. The alumina is a constituent of the clay, and varies with the amount of clay present in the soil; the iron represents a constituent which is essential to plant life, though only in small quantities; manganese is found in very small quantities in all plants, but its significance is not yet understood; magnesia is found in every plant, and though it is generally supposed that all soils are sufficiently furnished with this substance for the needs of the crop, it is nevertheless important to examine the relationship between the magnesia and the lime in the soil; and chlorine and sulphuric acid represent constituents of a plant which are necessary to its growth but are generally amply provided by the soil. The methods of analysis that have been followed are those adopted by the Agricultural Education Association. They are set out in Hall, "The Soil," second edition, 1908, p. 142.

1.—The Alluvial Soils. (*See* Tables on pp. 174-177.)

Origin and Distribution of the Alluvial Soils.—The most recent soils are the alluvial deposits which occupy the flats bordering the streams and rivers in the inland parts of the country and the much wider expanses of marshes along the coast line. The width of the former, generally river meadows among which the stream takes a sinuous course, is often regarded as evidence of a much greater rainfall in comparatively recent times, because no great period, geologically speaking, can have elapsed since they have been laid down, and the present rivers seem to overflow too rarely and to leave too little deposit behind to account for the considerable depth and extent of alluvial soil that has accumulated. It is to be remembered, however, that only within recent years have the river courses been kept open; before the settlement of the district they must, especially in the hill country,

have been continually choked by fallen timber and the like, until, as may be seen in Canada and parts of Scandinavia at the present day, the whole bottom of the valley was a wet swamp along which the water oozed in various ill-defined channels.*

The alluvium of the river valleys, since it consists of material washed off the uplands and brought down by the stream, must resemble in composition the soils bordering the stream a little nearer its source, and as the streams in our area are short the alluvial soils are often almost identical with the soils on the neighbouring formations, except for a little sorting of the particles effected by the running water. For example, soil 189 taken from the flats near the mouth of the Wey at Addlestone is indistinguishable from a Bagshot Sand soil. Soils 103 and 140 are essentially similar to the soils on Lower Greensand which forms hills bordering the river at the points from which the samples are taken. It is noticeable that soil 140 comes from rather higher up the valley than the Greensand outcrop, but whether this is evidence of the former greater extension of the Greensand escarpment or of rain wash from the hills, which, though lower down the valley, are still near and at a much higher level, cannot well be determined. Similarly, the soils from the Rother river meadows taken near Bodiam, Sussex, Nos. 174 and 285, are similar in type to the neighbouring Wadhurst Clay soils, though of a rather heavier character.

The alluvial Marsh soils present similar variations due to their differences of origin, both as regards the rocks from which the rivers derived their suspended matter and the situation of the particular field within the marsh. The formation of these marshes, so characteristic of the area in question, is evidently of very recent origin, and may still be seen in progress at the mouth of the Rother and other places.

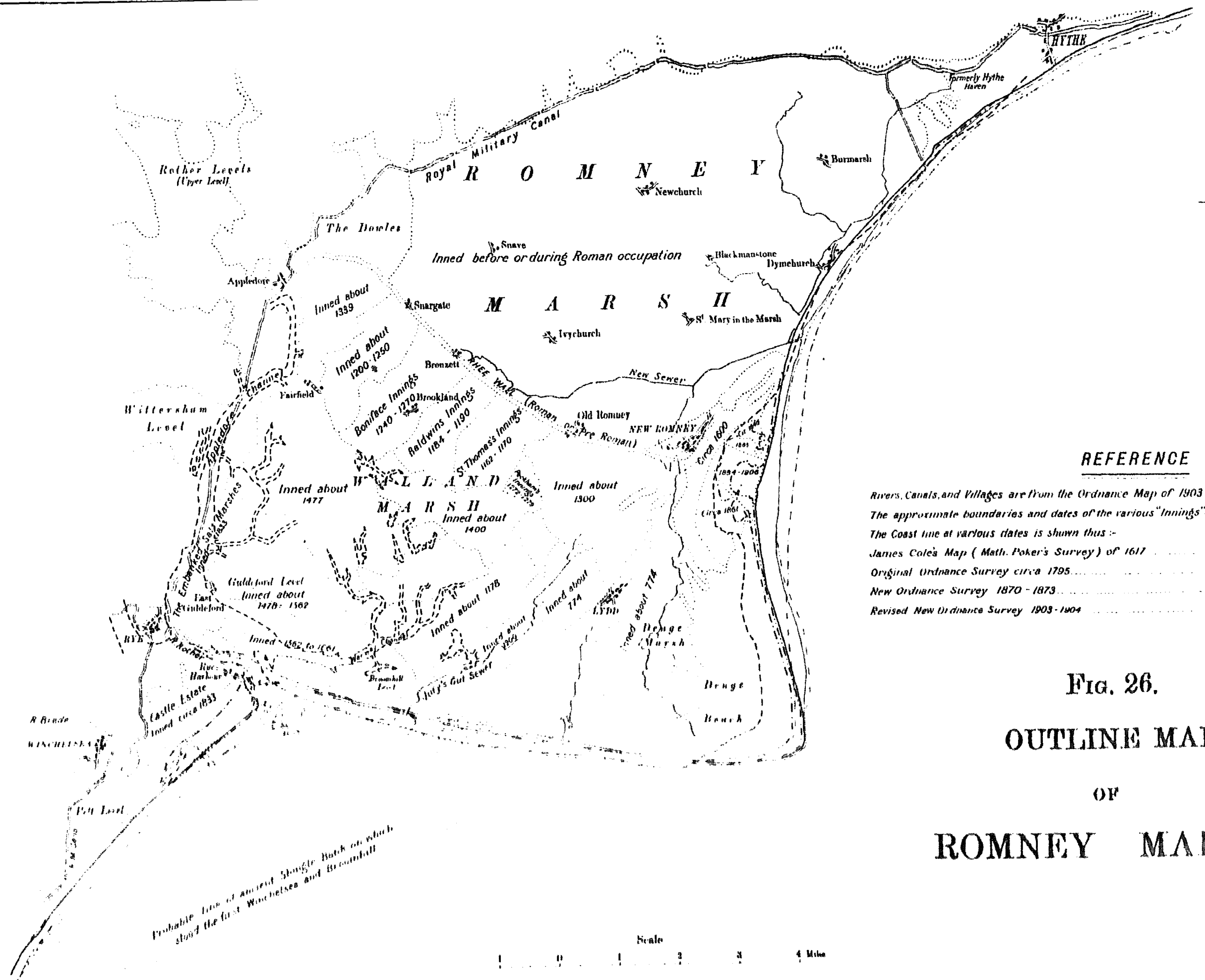
Romney Marsh is the largest of these areas; at the eastern extremity lies the Cinque port of Hythe, built on an old sea cliff of Lower Greensand, but now separated from the sea by some half-mile of meadow and shingle. From Hythe the low sea cliff, first of Lower Greensand and then of Weald Clay, runs nearly due east to Appledore, where the Marsh turns inland for some distance along the courses of the Rother tributaries and includes the Isle of Oxney, which is completely surrounded by the Levels. The former sea cliff is also seen in the Isle of Oxney; it begins again near Iden, whence it may be traced, with breaks for the Tillingham and Brede Valleys, by Rye and Winchelsea to the sea near Pett. Seaward of the cliff comes the flat marsh, mostly about 10 feet above high water mark; its length from Winchelsea to Hythe is about 20 miles, and its breadth from Appledore to New Romney is about 10 miles. The seaward end is formed by the promontory of Dungeness, a cape of shingle which is yearly pushing out further into deep water; the present irregular area of bare shingle banks or fulls is six miles or so long, and extends inland in places as much as three miles, right up to the

* The authors owe this suggestion to Mr. G. W. Lamplugh, F.R.S., of the Geological Survey.

town of Lydd. At Dungeness point itself the shingle shelves oft with startling abruptness, the five-fathom line being little more than a hundred yards out from the shore.

It is known that the eastern half, Romney Marsh proper, east of the Rhee wall of the Rother (which then ran from Appledore into the sea near New Romney) was dry land in pre-Roman times, since Roman coins and other antiquities have been repeatedly found all over the district. The western portion was at that time a tidal estuary running far into the land, with a belt of shingle and sand seaward, upon which the town of Lydd began to grow. The Walland and Denge Marshes, after one early reclamation about 774, were "inned" little by little under successive Archbishops of Canterbury, beginning with Becket in 1162-74, but much of the western end of the marsh near Rye, to which the course of the Rother was afterwards deflected, has only become dry land within the last hundred years or so. The map (Fig. 26), which we owe to Mr. C. Stokes of Ashford, shows the successive positions of the coast line since accurate surveys have been made, together with the "innings" and their dates. The process of gaining land is still going on at the Rother mouth; the tides fling up a bank of shingle far out in the shallow bay, and in the lagoon thus cut off the tidal waters deposit their silt, until the bank, by further accumulations of shingle and blown sand, at last cuts off the highest tides, and the muddy flat behind begins to cover itself with grass. The rapidity with which the work has been done is attested by the history of the Cinque Ports and ancient towns belonging to the Marsh—Hythe, New Romney, Lydd, Rye, and Winchelsea; once flourishing seaports, these towns are now left encircled by green meadows, and from them only a strip of sea is visible over the distant shingle bank. On the other hand, though the tides with their burden of shingle originally did the work of barring out the sea, they have not always proved equal to preserving it: the newly-won land still remained below high water mark, so that in exceptional storms the barrier would be burst and the salt waves would flood into the marshes. The hand of man has here stepped in to build up a sea wall, which is especially necessary because in several places the tides have changed their run with the growth of Dungeness, and tend to scour away the protecting shingle that they previously deposited. By careful groining, however, and by brushing with faggots, the face of the wall is maintained as a shingle bank and the sea is kept out of the levels; at the same time an elaborate system of drains and sluices gathers up the land water which drains into the marsh and runs it off at each low tide. The care of the sea wall and the drainage channels is in the hands of the Commissioners of the four "Levels," who levy scots upon the land they benefit amounting to from three to ten shillings per acre. Fig. 27 shows a typical view over Romney Marsh taken from Eastchurch church tower.

The processes which we can trace in some detail for Romney Marsh have been going on within historic times at the other river mouths; Pevensey Level, though not so large as Romney Marsh, occupies a corresponding position to the west, where the southern arm of the Weald Clay plain comes down to the sea.



REFERENCE

Rivers, Canals, and Villages are from the Ordnance Map of 1903-4

The approximate boundaries and dates of the various "Innings" are shown thus 1600

The Coast line at various dates is shown thus:-

James Cole's Map (Math. Poker's Survey) of 1617

Original Ordnance Survey circa 1795

New Ordnance Survey 1870-1873

Revised New Ordnance Survey 1903-1904

Fig. 26.

OUTLINE MAP OF ROMNEY MARSH.

Scale 1 0 1 2 3 4 Miles

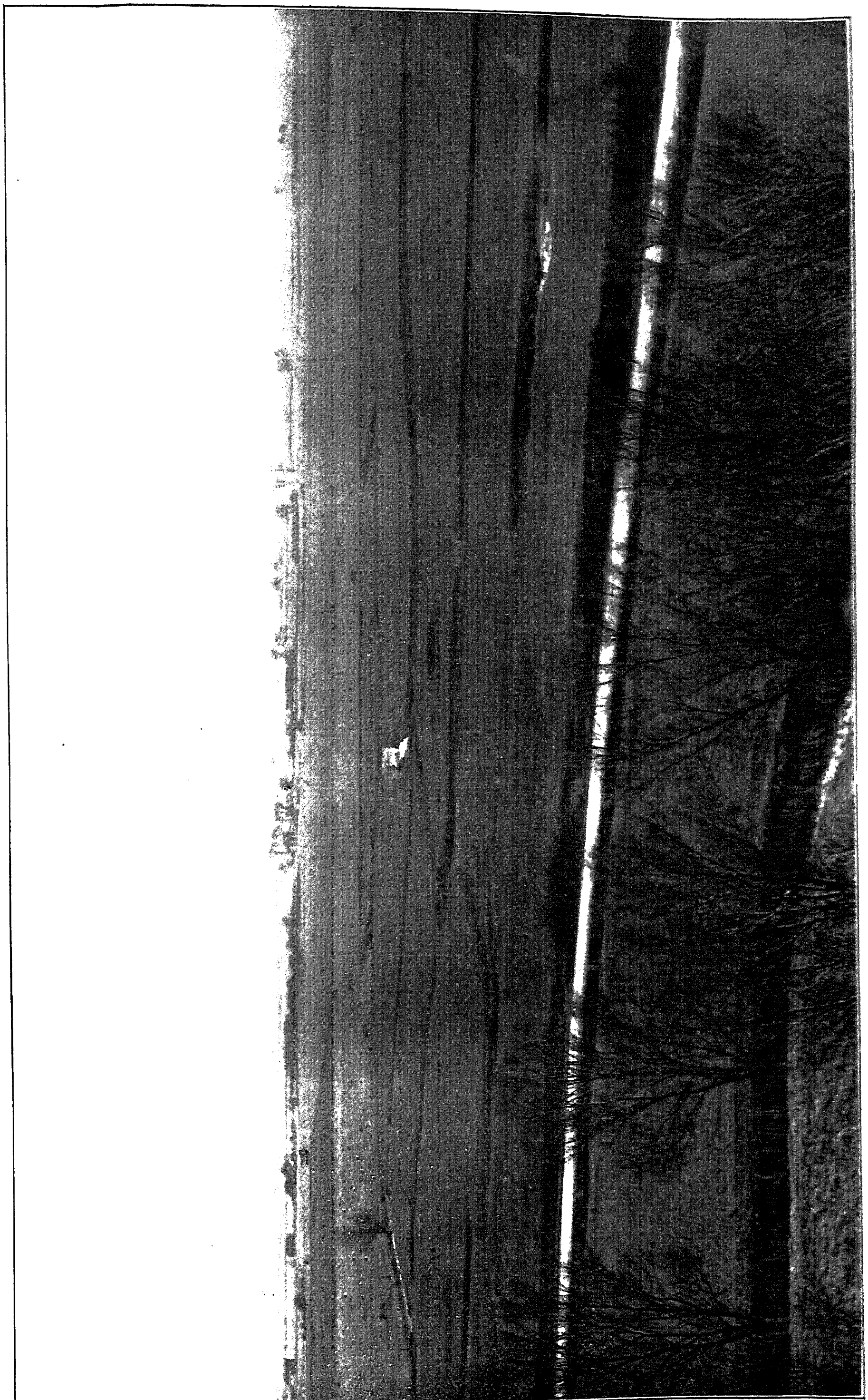


Fig. 27. View of Romney Marsh from Eastchurch Church Tower.

(To face p. 56.)

The Lewes and Loughton Levels form a tract of marsh land extending from Newhaven to Lewes and about 3½ miles across at the widest point; it is known locally as the "Brooks" (the alluvial meadows by the Rother are also called "Brooks"), and until the close of the eighteenth century it was tidal estuary and salt marsh for the greater part of the year, during the remaining months it was let for a trifling sum to chair-bottom makers for rush cutting. John Ellman, the improver of the Southdown Sheep, appears to have been the first to exert himself to reclaim this land, and his nephew, also John Ellman, about 1822 straightened the course of the Ouse and embanked the land on either side. The land is still below river level at high tide but is not particularly wet; it produces a very strong growth of herbage, which is generally grazed at first with sheep, laid in later for hay, and finally grazed again with cattle. The "brooks" are generally let with a certain amount of hill land, and are used for dairywork and sheep and cattle breeding rather than for fattening. The only manuring the land receives consists of occasional dressings of Basic Slag, which is found to answer very well.

Along the other Sussex rivers some alluvial stretches also occur; there is a considerable patch at Amberley, and by the Adur there are extensive river meadows. The "Brooks" of the Adur and Arun have, however, been very imperfectly drained, nor have the rivers been straightened and embanked, so that the land lies wet all the winter and until late in the spring. In the years when prices were high, a number of small creeks in the maritime district were reclaimed by building sea walls, but this land has not now any specially high reputation.

The course of the Thames as it opens seaward is lined by marshes all the way from Plumstead along the Hundred of Hoo and round the Isle of Grain into the Medway, beyond which the Sheppey, Luddenham, and Graveney Marshes stretch almost as far as Whitstable, where for the first time, except on the north coast of Sheppey, a veritable sea cliff comes down to the water's edge, though it is formed of nothing more resistant than London Clay. A little more eastward, where the old Roman fortress of Reculver guards the entrance to the Wentsum Channel inside the Isle of Thanet, the marshes begin again and sweep round into the present valley of the Stour, where they expand into the wide flat of the Sandwich marshes, overlooked by a little knoll on which stands the other Roman guardian fortress of Richborough. Here also the mediæval Port of Sandwich, separated from open water by two miles or so of meadow and sandhill, attests the formation of the marshes within historic times.

Agriculture on the Alluvial Soils.—All these marshes, with their similar origin, have certain features in common; in the first place they are not marshes in the usual sense of the word, because they consist of firm grazing and arable land, marked off, it is true, by ditches which are full of water except in the driest seasons, but possessing only rare patches that are permanently wet and boggy. In the main they are treeless expanses of grass; except for the plantations round the sparsely scattered farms and cottages, the

only woody growths to be seen are the sloe bushes and a few willows along the sides of ditches, and the occasional twisted elders and prostrate broom on the shingle banks to seaward. The fields are mainly covered by grass: parts of Romney Marsh still show a good deal of arable land, but though the land bears immense crops, labour difficulties have made arable farming increasingly difficult. Very few people live in the marshes; in Romney Marsh the villages are scanty and the churches often shut up; farmhouses even are rare, and generally only occupied by a shepherd; the farmers live somewhere on the outskirts and keep one "looker" to watch the stock on two or three hundred acres. The marshes are indeed not over healthy places to live in, though the agues and intermittent fevers which were once common have disappeared within the memory of living residents owing to the better drainage which now prevails.

The depopulation of Romney Marsh is said to have begun with the "Black Death," up to which time it was mainly under the plough; much of it was again broken up at the time of the Napoleonic wars and again about 1850-60, when corn prices were high, but since then it has returned to pasture. Many of the field names show that they were at one time arable.

The grazing land, which everywhere predominates, is often famous for its richness, though the fields differ much from one another. In each district may be found "fatting" pastures, on which feeding cattle and sheep can be got ready for market without the aid of any artificial food. The "fatting" fields are rarely continuous, but are generally surrounded by land which will merely keep the sheep growing or is only fit for breeding upon. The marsh pastures are, moreover, not very healthy for stock; not only are they unfit for growing sheep after the summer, but the losses in the flocks from various parasitic diseases and from what is known locally as "struck," a bacterial disease caused by an organism considered to be identical with that which induces "black quarter" in cattle. are very great, amounting to from 6 to 12 per cent. of the total number of sheep.

The soil is by no means even in quality; although Romney Marsh is famous for its richness, a certain amount of it is thin poor soil.

An examination of the sheep and cattle maps (Figs. 54 and 52) will show that in Romney Marsh and most of the Kentish Marshes sheep predominate and cattle occupy quite a secondary place, but in the Pevensey Levels there are practically no sheep and the land is heavily stocked with cattle. The comparative absence of cattle in Romney Marsh is set down to its dryness and lack of running water; horned stock do not thrive on the stagnant water of the ditches, which are also not full enough in the summer to retain cattle; indeed, in exceptional years they dry so much that the sheep of various owners unite and wander in vast flocks. Nowadays a few store cattle are often bought to eat off the rough grass before the fresh growth in spring, and others may be purchased to keep down the grass in seasons when it begins to be too plentiful for the sheep, but years ago when the marsh was wetter cattle were more plentiful and the necessary

bullock fencing was obtained from the oak woods of the neighbouring Weald. In the Pevensey Levels, and to a less degree in the Graveney and Sandwich Marshes, broad streams of running water are common; the Pevensey Levels also are wetter and carry a coarser vegetation.

The management of sheep in Romney Marsh has already been described; it only remains to add that the graziers who possess good pasture attach the utmost importance to keeping it grazed close. When the sheep first come down to the Marsh they are crowded on the land, often 20-30 to the acre, in order to eat everything off before the growing season begins; this is called "tegging" the land. From this flock the more forward sheep are continually drafted into the fatting fields, but every effort is made to stock the land up to its full limit and to prevent the grass from running to seed, especially in the earlier months. It is said that a field may be spoilt for the season by leaving the grass to run up for ten days or so in early May when growth is active. The amount of stock the more famous fields of the marsh will carry and fatten is incredible, and these rich fields are sometimes only separated by a ditch or a fence from others that will do no more than keep the sheep on them in a growing condition. Soil sample No. 200 is taken from a field near Lydd, reputed to be the strongest in the Marsh, on which as many as 50 sheep to the acre are sometimes put; it will fatten about eight sheep to the acre. Samples Nos. 198 and 226 are taken from land which will fatten six sheep to the acre; No. 161 from Graveney Marsh, and No. 177 from St. Mary's Marsh, are also taken from fields which are famous for their fattening quality.

The rich grazing land is never mown, for mowing is considered to damage the grazing for years afterwards; and land that has at some former time been under the plough is never considered to make good fatting pasture again, though Mr. A. Finn, of Lydd, has obtained fine pastures on arable land by sowing a good mixture of seeds and looking well after the pasture at first.

Ants are very abundant on these lands, and unless the ant-hills are cut over regularly the pastures are soon injured. In all the sheep marshes, whether in Romney or along the Thames, the predominant feature of the vegetation on the best fields is Rye grass, the shining leaves of which give the whole pasture a bright sheen in the sunlight. Other grasses present in notable quantity are the Bent grass (*Agrostis stolonifera*), Crested Dogstail (*Cynosurus cristatus*), and Meadow barley (*Hordeum pratense*), the two latter being particularly prominent on the poorer lands in late summer, because of their dried culms which the stock refuse. There is always a good deal of white clover to be seen, and the herbage forms a thick close sole with a characteristic firm spring under the foot. In order to try if the differences in the feeding value of the different fields could be correlated with the botanical character of the herbage, Mr. H. W. Clements in 1908 railed off two pieces of his fields at Orgarswick in Romney Marsh, one from a rich field, No. 226, which will fatten six sheep to the acre, the other from an adjoining field about 250 yards away that will only keep tegs growing and improving through

the summer. When the grasses were in flower samples were cut and a botanical analysis made with the following results:—

—	No. 226, Fatting Land.	No. 236, Non-fatting Land.
	Sample Leafy.	Sample Stemmy.
	Per cent.	Per cent.
Perennial Rye-grass (*Lolium perenne*)... ...	50·6	56·6
Bent (*Agrostis vulgaris*)	20·2	2·6
Crested Dogstail (*Cynosurus cristatus*) ...	15·4	15·1
Yellow Oat (*Avena flavescens*)	4·3	11·8
Meadow barley (*Hordeum pratense*)	0·2	4·6
Timothy (*Phleum pratense*)	0·4	2·0
Rough-stalked Meadow-grass (*Poa trivialis*)...	2·1	1·2
Yorkshire Fog (*Holcus lanatus*)	0 9	—
Cocksfoot (*Dactylis glomerata*)	—	0·1
Sheep's Fescue (*Festuca ovina*)	0·1	0·3
White Clover (*Trifolium repens*)	2·1	0·9
Buttercup (*Ranunculus bulbosus*)	3·6	3·7
Various weeds	0·1	1·1

Without doubt the conditions under which these samples were obtained, cut after running up to hay, explains the low proportion of white clover, which would bulk very much higher in the material that is continually grazed off. Putting this fact aside, however, there is but little in the botanical composition of the two herbages to account for their great difference in feeding value; the best contains a little more clover and particularly more Bent grass, but this has never been regarded as especially valuable. The herbage from the poorer land contains more Oat grass, never considered of much account, more Meadow Barley, a bad grass, and more miscellaneous weeds, though both pastures are singularly free from weeds. Though the analysis shows about the same proportion of buttercup in each, the non-fatting fields in early summer are easily distinguished by the way they are covered with buttercup blossoms, whereas few flowers are seen on the fatting fields. Rushes also show distinctly on the non-fatting fields. A better clue to the superiority of No. 226 is perhaps to be found in the fact that the grass on No. 236 easily runs up to stem, and has to be stocked with great care to prevent it so doing; even in the hay samples No. 226 showed a much more leafy herbage. On making a chemical analysis of the two lots of hay, that from the good land was found to possess a little more nitrogen and phosphoric acid, though the differences are not very great, but it also shows a smaller proportion of fibre. These differences are not accidental, since they persist in the analyses of each species of grass sorted out from the two lots of hay; there was always a little less fibre and a little more nutrient material in the grass from the fatting pasture. Now the more fibre a food contains the more work the animal has to do in order to digest the food, until a point is reached when the energy an animal derives from the digested part of the food is all used up in the work of digestion and nothing is left over for other work, nor is there any surplus

out of which to make flesh or fat. No amount of food of this quality will fatten the animal, and though the grass on the poorest fields is never so hard of digestion as this, it may yet leave the animal but a small margin on which to fatten. This explanation is, however, based upon the experience of a single season at one station and may not be found to hold generally; it must, therefore, be taken as a tentative conclusion only, which may require modification in the light of the further investigation now being pursued. The grass from the Romney Marsh fields is always much richer in nitrogen than other samples taken from the marshes elsewhere.

Another sample of grass was taken in 1908 from one of the Sandwich Marshes, but from a field which does not compare with the Orgarswick fields, because it is regularly laid up for hay and heavily stocked in winter with sheep receiving artificial food. The botanical analysis was as follows:—

	per cent.
Soft Brome (*Bromus arvensis and B. mollis*) ...	38·6
Meadow Barley (*Hordeum pratense*)	12·6
Cocksfoot (*Dactylis glomerata*)	12·3
Perennial Rye-grass (*Lolium perenne*)	7·9
Yorkshire Fog (*Holcus lanatus*)	7·4
Rough-stalked Meadow-grass (*Poa trivialis*) ...	3·6
Crested Dogstail (*Cynosurus cristatus*)	2·0
Timothy (*Phleum pratense*)	2·0
Couch (*Triticum repens*)	1·8
Other grass species	2·4
White Clover (*Trifolium repens*)	5·6
Other *Leguminosae*	1·3
Weeds	2·5

The effect of the haying is evident in the comparative absence of Rye grass, Crested Dogstail, and other finer grasses—their place being taken by such coarse species as the Bromes, Cocksfoot, and Yorkshire Fog. Again, however, the absence of weeds shows the richness of the land.

Composition of the Alluvial Soils.—The details of the analyses of these alluvial soils give little clue to the causes of their richness. In the first place they are extremely variable in mechanical composition; not only, as in the riverside alluvials, may one soil be built up of material washed from a very light and another from a comparatively heavy soil formation, but in different parts of the tidal estuary, as it silted up, deposits of very different character would be laid down. In the Romney Marshes, for instance, banks are often to be found which show shingle and sand close to the surface, though generally the good marsh soils are of a heavy type, and possess a subsoil of stiff blue clay known locally as "clyte."

The soils from Lydd and Midley form an exception: they are distinctively light loamy sands, containing little or no coarse sand, but fine sand is the dominant fraction and constitutes two-thirds of the whole, while the clay and the silt are both low, especially in the soil from the best land of all. Doubtless the basis of these soils was blown sand, for no other agency is likely to sort out material of such a grade.

The other Romney Marsh soils from Hope-all-Saints and from Orgarswick, on its eastern side, are much heavier; again there is no coarse sand or gravel, but only about one-third of the whole is fine sand, the rest being pretty evenly divided between the silts and the clay, the latter amounting to more than 20 per cent. These soils are not unlike the two Bodiam soils taken from a point where the Rother just begins to be tidal, though the latter soils are a little heavier and contain rather more clay but less fine sand.

The soil from the Pevensey Levels is again very similar to the Bodiam soils; doubtless the similarity of these and the Orgarswick soils is due to their common origin from material washed off the Wealden area. The Thames and Sandwich Marshes form another group, all much alike and heavier than anything previously described; in this group of soils not only are coarse sand and gravel absent, but the fine sand never reaches 10 per cent., the fine silt is about 20 per cent., and the clay amounts to 30 per cent. or over. This would seem to indicate that the neighbouring London Clay formations have played a dominant part in the formation of these alluvials.

One instructive feature about the alluvial soils is the similarity of composition of the surface and the subsoil. In the sedentary soils which have been formed *in situ*, the surface layer is generally coarser in texture than the subsoil, because during the whole process of formation of the soil there has been a washing down and washing away of the finest material, leaving the larger and coarser grains on the surface. Where the substratum is clay, the surface may have become considerably lightened by this process, but as soon as one gets below the plough level the subsoil sets in, very little altered from the pure clay of still greater depths. But the alluvial soils were deposited as uniform material sorted by running water, they are of comparatively recent origin, and in many cases have been always covered with grass, so that the washing away of the finest material in the surface layer has not progressed very far.

But though the surface soil resembles the underlying layer very closely, yet not infrequently a complete and sudden change in composition may set in not far below the surface. This represents a change in the conditions under which the original deposit was laid down; in the tidal estuary the bay in which sand was collecting gets cut off from time to time by a bank and only flooded at high water, whereupon a much finer grade of material begins to collect, or conversely from the breaking down of such a bank a silt and clay deposit may be succeeded by a layer of sand.

In Table I. will be found a series of analyses pushed to much greater depths than usual; in all cases the first and second foot possess much the same composition, but at Midley, somewhere between the second and third foot, the heavy surface material gives place to a soil composed almost wholly of fine sand. At Orgarswick no change was found down to a depth of seven feet, when a bed of peat was encountered; similarly at Hope-all-Saints the heavy soil persists to a depth of six feet, while at Lydd a bed of shingle occurs at no great depth.

Table I.—Mechanical Analyses of consecutive 12 inch* depths of Soils from Romney Marsh.

273. MIDLEY. Poor field.

—	1st 12 ins.	2nd 12 ins.	3rd 12 ins	4th 12 ins.	5th 12 ins.	6th 12 ins.	7th 12 ins.
Fine gravel, above 1 m.m. ...	0·03	0·04	0 07	0·06	0·02	0 01	
Coarse sand, 1–0·2 m.m. ...	0·09	0·12	0·10	0·17	0·49	0·56	
Fine sand, 0·2–0·04 m.m. ...	38·56	37·63	56·44	66·94	74·20	75·22	
Silt, 0·04–0·01 m m.	13·79	13·81	10·29	7·71	5·62	4·48	No
Fine silt, 0·01–0 02 m.m. ...	15·13	15·63	10·42	6·87	5·42	4·01	sample
Clay, below 0·002 m.m. ...	19·52	17·99	9·83	6·87	4·68	4·31	taken.
Calcium Carbonate	0·34	4·18	6·48	6·96	7·24	6·57	
Loss on ignition	14·81	8·23	5·66	3·97	3·15	0·77	
Moisture	3·01	3·41	1·24	1·64	1·67	1·52	
Total	105·28	101 04	100·53	101·19	102·49	97·45	
Stones	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	
Fine silt, 0 01–0·005 m.m. ...	9·55	7·98	4·99	3 31	2·99	1·83	
„ „ 0·005–0·002 m.m. ...	5·58	7·65	5·43	3·56	2·43	2·18	

283. MIDLEY. Good field.

—	1st 12 ins.	2nd 12 ins.	3rd 12 ins	4th 12 ins.	5th 12 ins.	6th 12 ins.	7th 12 ins.
Fine gravel, above 1 m.m. ...	0·04	0·03	0·07	0·02	0·19		
Coarse sand, 1–0·2 m.m. ...	0·46	0·30	0·28	0·36	0·66		
Fine sand, 0·2–0·04 m.m. ...	46·65	36·85	50·58	69·20	73·89		
Silt, 0·04–0·01 m.m.	10·94	13·66	10·10	6·34	4·93	No.	No.
Fine silt, 0·01–0·002 m.m. ...	13·91	17 20	7·00	6·41	8·65	sample	sample
Clay, below 0·002 m.m. ...	13·09	17·97	15·01	6·79	4·91	taken.	taken.
Calcium Carbonate	0·11	3·63	4·86	6·29	7·01		
Loss on ignition	11·55	9·25	6·71	4·28	3·00		
Moisture	3·69	2·94	1·68	0·78	0·76		
Total	100·44	101·83	96·29	100·47	104·00		
Stones	Nil.	Nil.	Nil.	Nil.	Nil.		
Fine silt, 0·01–0·005 m.m. ...	6·61	9·34	1·61	3·12	5·84		
„ „ 0·005–0·002 m.m. ...	7·30	7·86	5·39	3·29	2·81		

236. ORGARSWICK. Poor field.

—	1st 12 ins.	2nd 12 ins.	3rd 12 ins	4th 12 ins.	5th 12 ins.	6th 12 ins.	7th 12 ins.
Fine gravel, above 1 m.m. ...	0·04	0·06	0·06	0·07	0·09	0·02	0·07
Coarse sand, 1–0·2 m m. ...	0·26	0·16	0·52	0·07	0·19	0·13	0·22
Fine sand, 0·2–0·04 m.m. ...	25·20	29·01	33·27	23·63	18·03	25·45	22·11
Silt, 0·04–0·01 m.m.	17·46	16·01	15·65	18·08	17·69	15·48	19·36
Fine Silt, 0·01–0·002 m.m. ...	16·52	15·91	11·93	14·88	16·83	14·37	15·61
Clay, below 0·002 m.m. ...	26·01	25·48	21·52	22·55	24·17	25·22	25·44
Calcium Carbonate	0 32	1·36	7·58	10·96	8·22	7·36	7·88
Loss on ignition	12·40	9·31	7·57	7·37	8·21	8·76	7·70
Moisture	4·14	3·55	2·07	2·05	2·62	2·58	2·17
Total	102·35	100·85	100·17	99·66	96·05	99·87	100·56
Stones	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Fine silt, 0·01–0·005 m.m. ...	9·29	9·49	7·47	8·54	11·16	8·88	9·63
„ „ 0 005–0·002 m.m. ...	7·23	6·42	4·46	6·34	5·67	5·49	5·98

226. ORGARSWICK. Good field.

—	1st 12 ins.	2nd 12 ins.	3rd 12 ins	4th 12 ins.	5th 12 ins.	6th 12 ins.	7th 12 ins.
Fine gravel, above 1 m.m. ...	0·05	0·09	0·02	0·11	0·16	0·10	0·09
Coarse sand, 1–0·2 m.m. ...	0·56	0·38	0·47	0·59	0·31	0·25	0·77
Fine sand, 0·2–0·04 m.m. ...	28·12	27·48	25·21	29·25	20·34	16·65	25·94
Silt, 0·04–0·01 m.m.	15·63	16·67	17·60	16·90	18·51	17·09	17·84
Fine silt, 0·01–0·002 m.m. ...	17·63	14·38	15·37	13·37	15·70	15·86	15 43
Clay, below 0·002 m.m. ...	22·81	27·77	26·01	22·60	26·61	30·46	23·91
Calcium Carbonate	Nil.	2·52	6·86	9·50	7·78	9·60	6 44
Loss on ignition	13·25	9·99	8·31	7·50	8·34	9·06	9·62
Moisture	3·94	3·75	2·56	2·10	2 28	3·35	2·55
Total	101·99	103·03	102·41	101·92	100·03	102·42	102·59
Stones	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	0·02
Fine silt, 0·01–0·005 m.m. ...	9·42	8·73	9·55	8·15	9·86	10·16	8·84
„ „ 0·005–0·002 m.m. ...	8·21	5·65	5·82	5·22	5·84	5·70	6·59

* The figures in the later tables (Chap. VI.) refer to 9 inch samples and are therefore not directly comparable with these.

225. Lydd. Poor field

—	1st 12 ins.	2nd 12 ins.	3rd 12 ins.	4th 12 ins.	5th 12 ins.	6th 12 ins.
Fine gravel, above 1 m.m....	0·11	0·27	0·12	0·13	0·17	0·03
Coarse sand, 1–0·2 m.m. ...	3·10	2·44	2 33	3·36	8·15	9·74
Fine sand, 0·2–0·04 m.m. ...	67·51	69 88	72·61	75·33	73·12	73·30
Silt, 0·04–0·01 m.m. ...	6·18	6·22	4·73	3·26	2·45	2·27
Fine silt, 0·01–0·02 m.m. ...	6·87	4·31	5·08	3·32	3·12	2·47
Clay below, 0·002 m.m. ...	5·08	7·70	5·84	4·37	3·55	3·83
Calcium Carbonate	0·20	1·42	5·20	8·68	5·21	5·22
Loss on ignition	9·45	5·53	4·82	3·73	3·42	3·07
Moisture	2·28	1·57	2·30	1·93	1·83	1·67
Total	100·78	99·34	103·03	104·11	101·02	101·60
Stones	Nil.	0·16	0·09	0·66	Nil.	1·70
Fine silt, 0·01–0·005 m.m. ...	3·17	2·29	3·03	1·45	1·53	0·69
„ „ 0·005–0·002 m.m.	3·70	2·02	2·05	1·87	1·59	1·78

Lydd. Better but not good.

—	1st 12 ins.	2nd 12 ins.	3rd 12 ins.	4th 12 ins.	5th 12 ins.	6th 12 ins.
Fine gravel, above 1 m.m....	0·09	0·05	0·05	0·85		
Coarse sand, 1–0·2 m.m. ...	2·65	0·98	1·05	5·21		
Fine sand, 0·2–0·04 m.m. ...	34·73	27·84	15·84	18·05		
Silt, 0 04–0·01 m.m. ...	22·52	22·74	22·53	18·26	No sample taken.	No sample taken.
Fine silt, 0·01–0·002 m.m. ...	10·56	11·82	16·93	14·71		
Clay below 0·002 m.m. ...	17·06	28·29	30·38	30·07		
Calcium carbonate	0·08	1·08	3·74	2·04		
Loss on ignition	12·05	9·32	9·34	9·78		
Moisture	3·52	3·53	2·75	1·72		
Total	103·26	105·65	102·61	100·69		
Stones	0·61	Nil.	Nil.	51·43		
Fine silt, 0·01–0·005 m.m. ...	5·41	8·36	13·80	10·80		
„ „ 0·005–0·002 m.m.	5·15	3·46	3·13	3·91		

198. Lydd. Good field.

—	1st 12 ins.	2nd 12 ins.	3rd 12 ins.	4th 12 ins.	5th 12 ins.	6th 12 ins.
Fine gravel, above 1 m.m....	0·09	0·13	0·05	0·03	0·02	0 03
Coarse sand, 1–0·2 m.m. ...	2·57	1·46	0·63	5·69	20·35	17·66
Fine sand, 0·2–0·04 m.m. ...	53·95	59·68	59·15	71·91	64·09	66·32
Silt, 0·04–0 01 m.m. ...	20·05	13·01	13·34	5·58	2·13	3·24
Fine silt, 0·01–0·002 m.m. ...	6·14	6·63	5·51	2·06	2 46	2·17
Clay below, 0·002 m.m. ...	7·41	11·07	8·13	4·22	2 13	3·09
Calcium Carbonate	0·23	4·44	9·60	7·50	5·44	8·42
Loss on ignition	9·80	5·52	4·56	2·20	1·97	0·18
Moisture	2·71	2·03	1·27	1·20	1·87	1·87
Total	102·95	103·97	102·24	100·39	100·46	102·98
Stones	0·99	0·70	0·01	Nil.	Nil.	Nil.
Fine silt, 0·01–0·005 m.m. ...	4·47	4·95	3·29	0·45	1·26	1·09
„ „ 0·005–0·002 m.m.	1·67	1·68	2·22	1·61	1·20	1·08

275. Hope-all-Saints. Poor field.

—	1st 12 ins.	2nd 12 ins.	3rd 12 ins.	4th 12 ins.	5th 12 ins.	6th 12 ins.
Fine gravel, above 1 m.m....	0·15	0·50	Nil.	0·03	0·02	0·03
Coarse sand, 1–02 m.m. ...	0·62	0·74	0·06	0·11	0·12	0·23
Fine sand, 0·2–0·04 m.m. ...	18·10	17·83	13·18	20·37	20·71	26·32
Silt, 0·04–0·01 m m. ...	25·45	24·12	28·50	15·92	22·19	20·37
Fine silt, 0·01–0·002 m.m. ...	18·58	19·14	12·20	8·88	10·95	11·10
Clay below, 0·002 m.m. ...	24·61	27·04	33·64	25·73	24 38	22 98
Calcium Carbonate	0·18	0·14	3·68	10·78	14·52	10·78
Loss on ignition	14·70	10·50	10·43	8·59	7·14	7·84
Moisture	4·77	4·96	2·57	2·53	2·37	2·23
Total	107·16	104·97	104·26	92·94	102·40	101·88
Stones	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
Fine silt, 0·01–0·005 m.m. ...	10·00	10 62	6·87	5·74	8·55	7·25
„ „ 0·005–0·002 m.m.	8·58	8·52	5·33	3·14	2·40	3·85

281. Hope-All-Saints. Good field.

—	1st 12 ins.	2nd 12 ins.	3rd 12 ins.	4th 12 ins.	5th 12 ins.	6th 12 ins.
Fine gravel, above 1 m.m. ...	0·15	0·15	0·06	0·05	0·04	0·03
Coarse sand, 1–0·2 m.m. ...	3·07	3·55	1·05	0·73	0·42	0·24
Fine sand, 0·2–0·04 m.m. ...	27·32	25·86	18·95	22·39	23·40	25·04
Silt, 0·04–0·01 m.m. ...	17·38	20·90	13·09	16·30	15·67	17·34
Fine silt, 0·01–0·002 m.m. ...	6·57	9·72	19·11	11·21	10·28	9·72
Clay, below 0·002 m.m. ...	18·13	22·09	23·39	23·72	22·12	21·03
Calcium Carbonate	0·66	8·00	13·12	11·54	12·68	13·46
Loss on ignition	16·55	8·15	6·20	9·53	9·03	8·67
Moisture	4·65	3·40	2·78	1·75	1·64	2·84
Total	94·48	101·82	97·75	97·22	95·28	98·37
Stones	Nil	0·02	Nil	0·02	Nil	Nil
Fine Silt, 0·01–0·005 m.m. ...	4·59	7·44	13·94	8·51	6·36	6·88
,, ,, 0·005–0·002 m.m.	1·98	2·28	5·17	2·70	3·92	2·84

The mechanical analyses of the Marsh soils also fail to throw any light on the superiority of one field over its neighbour; not only do the soils from the rich fields in different places show no similarity, but if the best soil at Lydd be compared with its medium and poor neighbours no significant differences can be found. Similarly the Orgarswick poor soil is almost identical with the Orgarswick rich land, being only a trifle heavier.

Among the alluvial soils are some of the true river meadow type, taken from comparatively small areas bordering the rivers instead of the wide flats of the Marshes we have been previously considering.

Soil No. 140, from Yalding, and No. 103, from Nutfield, are somewhat similar in composition, being light sandy loams, rich in fine sand and silt. They present many features in common with the Lower Greensand soils, from which they have undoubtedly been derived. Soil No. 189 is taken from a farm bordering on the river Wey, about a mile above its junction with the Thames. It is composed almost wholly of coarse and fine sand, and presents a strong likeness to the Bagshot Sands which the river has been crossing for some miles and which, indeed, form the only elevated ground adjacent to the land in question. Though of alluvial origin this soil should really be regarded as Bagshot sand which has been washed into the river and re-deposited very soon after, with but little change beyond a slight reduction in the proportion of the finest particles. Of very similar character are soils Nos. 295-7, which should, from a geological point of view, be associated with the Brick Earth formation, to be next considered. These soils belong to an area of drift which covers much of the London Clay to the south-west of London—Mitcham Common for example; they are of alluvial origin, but belong to an earlier epoch than the true recent alluvials with which we have just been dealing. As a rule, however, these older alluvials consist chiefly of Brick Earth, and only in places pass into patches of gravel and sand such as

constitute the area under consideration. The soils have, however, been placed in their present position because of their similarity in composition to the Weybridge soil, No. 189, a similarity which is in all probability due to a common origin from Bagshot Beds, though the Bagshot Beds have been almost wholly denuded away from the Mitcham district, the patch forming Wimbledon Common being the nearest outlier. The analysis shows these soils to be exceedingly light in character, with an exceptional proportion of coarse sand. Soil No. 295 contain as much as 76 per cent. of coarse and fine sand, chiefly coarse; though it is used for market gardening and grows fair crops by the aid of immense dressings of London dung, it is notorious as a soil that blows when strong winds set in during the spring.

Turning to the chemical composition of the soils, it will be seen that there is generally a very small proportion of carbonate of lime, which is sometimes barely perceptible. The exception is the soil from the Stonar Marsh, which shows nearly 8 per cent. in the soil and over 14 per cent. in the subsoil; this probably represents a deposit of shell marl such as is still being laid down near the mouth of the Stour. The Worth Marsh also shows 2·5 per cent. and the Pevensey Level 2·5 per cent. in the subsoil, again probably a shell deposit. In several cases the carbonate of lime indicated is evidently of artificial origin and represents lime or chalk that was put on when labour for such purposes was a little cheaper; Orgarswick No. 236, Weybridge No. 189, and Ewhurst No. 285 are examples of this kind. Despite the lack of carbonate of lime the alluvial soils are never acid; they are probably just kept at the neutral point by the land water, which is always distinctly alkaline with bicarbonate of lime.

The most characteristic feature of the analysis of these alluvial soils, mostly old pasture land, is their richness in organic matter and nitrogen, not only in the soil but in the subsoil. All old grass land contains much organic matter and nitrogen in the surface soil, but these alluvials average 0·19 per cent. of nitrogen and 6·67 per cent. of organic matter in the subsoil, because they are made up of material which had been washed off some other surface soil before it was re-deposited by the river. It is the depth to which the rich soil extends, the lack of any raw unweathered subsoil, and the presence of a permanent water table close below the surface, which chiefly account for the fertility of the alluvial soils. For example, soil No. 189 from Weybridge, is identical in mechanical composition with the soil of the barren Bagshot wastes close at hand, and chemically also it is far from rich; in every respect it is thus as unlike a wheat soil as possible, yet it grows heavy crops of wheat of good quality, all because it has permanent water two or three feet below the surface.

The proportion of organic matter and nitrogen increases with the heaviness of the soils; the Lydd soils are not so rich as the Orgarswick, which in time fall below the soils of the Thames and Sandwich Marshes. The Stonar soil forms an exception to this rule, but high nitrogen content often goes with high calcium carbonate.

The analyses considered in detail show in all these alluvial soils a high percentage of organic matter and nitrogen, the latter sometimes amounting to 0·5 to 0·6 per cent.

The Potash content is high on all the heavier soils, only the sandy soils from the neighbourhood of Lydd showing less than 0·5 per cent., while in the marshes derived from the London Clay it may rise to over 1·0 per cent. It is lower in the soils of the flats along the rivers having their course in the Hastings beds, as might be expected from the low potash content of the Hastings Sand. In the alluvials also the subsoil generally contains more potash than the soil. The available potash is also high, being generally about 10 per cent. of the total potash.

In the heavier soils the Magnesia amounts to about 0·5 per cent., rising exceptionally in the St. Mary's soil to 1·3 per cent.; in the sandy soils it is lower, from 0·2 to 0·3 per cent. In many of the soils the amount of Magnesia is equal to, and in some it is actually more than, that of Lime.

The Alumina and Oxides of Iron call for no comment: the Alumina is as usual about one-third of the weight of Clay, while the Iron varies between 3·5 and 5·5 per cent. of the heavier soils, and is about 2·5 per cent. of the lighter soils. The Iron is nearly always in the ferric state.

Of Manganese there is little or none.

The Phosphoric Acid averages about 0·13 per cent., the exceptional cases being the Yalding soil No. 140, where it rises to ·258 per cent. and one of the Rother "brooks," where it amounts to ·343 per cent., but it is known that this field had recently received very heavy dressings of Basic Slag. In the subsoil there is less phosphoric acid than in the soil, generally about 0·1 per cent.; but the variations in the amount of phosphoric acid either in soil or subsoil cannot be correlated with any other factor. The available phosphoric acid amounts to about ten per cent. of the total, the exception being the Weybridge soil, No. 189, where it is about one-third of the total. The Sulphuric Acid is high in these soils rich in organic matter, between 0·1 and 0·15 per cent.

Manuring of the Alluvial Soils.—With soils that are so generally grazed the question of manuring rarely comes up, but where the river alluvials are under arable cultivation their treatment should be of the same nature as that of the neighbouring soils from which they have been derived. As a rule the alluvials are somewhat blended and show no special deficiencies to be corrected by manuring; they require a general manuring adjusted to the crops which they carry rather than one determined by the soils themselves. In nearly all cases, however, alluvial soils are deficient in carbonate of lime and are the better for liming or chalking; in Romney Marsh chalk is always preferred to lime. A good guide to the need for chalk or lime is to be obtained from the look of the water in the ditches; if this is rusty and covered with an iridescent scum it is a sign of some sourness in the subsoil which would be improved by lime.

On the grass land manure is never used, though in many cases, where it has been customary to feed large quantities of cake to the stock year after year, better results would be obtained if the expenditure on food were reduced and some lime or basic slag bought in its place. Often the herbage is over rank and too charged with nitrogen; the use of mineral manures would give it a better feeding value so that the land would carry the same amount of stock at much less cost for cake. Where basic slag has occasionally been tried the farmer generally reports that he could never see where it had been put on, but on these rich lands, which already carry a good growth of white clover, basic slag must not be expected to revolutionise the aspect of the herbage as it will on the poor clays. Its value will be found in the higher feeding value of the herbage, the stock will graze more frequently on the portions to which the basic slag has been applied, and by actual trial it has been found that the grass of some of the rich Rother "brooks" will do more work after treatment with basic clag, so that a saving can be effected in the cake bill on the farm that is much greater than the cost of the fertiliser.

2. The Brick Earths.

Origin and Distribution of the Brick Earths.—The Brick Earths represent the alluvial soils of an earlier epoch; they exist in patches of no great extent in the valleys of the Thames and the Kentish rivers at some little elevation above the present water level, and are the remains of alluvial deposits which once stretched widely across the earlier valleys, having been laid down at a time when the rivers ran in greater volume than they do at present. As worked flints and the bones of the mammoth and other extinct animals are found in them, they must have been formed since the advent of man though long before historic times, when the Straits of Dover had not been cut but England was joined to the Continent and the Thames was a tributary of a much larger Rhine.

From the geological point of view the Brick Earths are contemporaneous with certain valley gravels and pure sands at the same level and laid down by the same running water; they merge into them imperceptibly, and sometimes the three deposits are so closely intermingled and localised that it is impossible to map them apart with accuracy. Soils 295-7 belong to this epoch geologically but have been included with the alluvials because of their resemblance to certain recent soils formed in the same way by washing off the Bagshot Beds. The sands and gravels are, however, less extensive, and have no agricultural importance, except that occasionally the behaviour of a bed of Brick Earth may be modified by the presence of gravel or sand at no great distance below the surface. In two portions of the three counties the brick earth beds assume considerable importance and cover fairly wide areas, giving rise to soils of great farming value. In East Kent, from the valley of the Cray eastwards as far as Faversham, the Brick Earth forms a belt about 30-50 feet above sea-level, much cut up and intersected by later erosion; broad patches of the same formation

are also found on the eastern side of the Stour valley. The other large area is the maritime district of Sussex, where all the lower slopes of the chalk and the tertiary formations resting upon it are overlaid by Brick Earth, south of a line stretching from Brighton to Lancing, Chichester and Emsworth. Just along this line there is a narrow strip, about four miles wide at its broadest point near Chichester, but narrowing both east and west, known as valley gravel or "Coombe Rock"; the true Brick Earth comes south of this. In the valley gravel belt water-worn gravel, known locally as "shrave," comes close to the surface; the soil is rather lighter than the Brick Earth proper, and is easily distinguished from it by the abundance of pebbles. The valley gravel land commands a considerably lower rental than the Brick Earth, being let as a rule at about 10*s*. per acre. The comparative poverty of the soil may also be seen in the width of the roads, which often have a broad strip of green on either side, whereas the roads on the Brick Earth are narrow and are now worn deep below the level of the adjoining fields.

The Brick Earth represents the most generally fertile soil in the area; it is a finely-tempered loam in which fine sand and silt predominate, making it easy to work under the plough, but at the same time there is enough fine silt and clay to give "body" as well as water-holding capacity to the soil. It is in nearly all cases naturally under-drained by resting upon the Chalk or upon the light sands of the Thanet formation; its depth varies from a thin layer, hardly distinguishable from the underlying material, to a deposit 14 or 15 feet thick. Properly it is free from stones, though, as has already been said, in places it contains beds of or merges into gravel, and over the one band of "coombe" in Sussex it is full of small waterworn stones.

Agriculture on the Brick Earths.—In East Kent the Brick Earth is almost wholly under the plough, except for the extensive grass orchards of apple and cherry which lie on this formation, especially in the neighbourhood of Faversham, Sittingbourne, and Teynham. In the neighbourhood of Sittingbourne large areas have been dug up and burnt to bricks, and very generally the surface soil has been thrown back, and planted with black currants after the brick-making had moved forward. Nearly all the best cherry orchards lie on the Brick Earth, and for them no better soil can be specified. All kinds of fruit are grown on this soil—gooseberries, currants, and plums, as well as the apples and cherries already mentioned, and though the free stock is generally used a good many orchards of dwarf apples on paradise stocks have been recently planted. Hops form another favourite crop. Here are grown the choicest East Kent Goldings, the plants of which live long and remain healthy, and even when they are worn out the land will bear replanting with hops and continue to yield crops whose magnitude is only excelled by the Fuggles plantations on the best Mid-Kent and Wealden soils. So valuable is the Brick Earth reckoned for hops and fruit that no great extent of it exists under ordinary arable farming, though it grows all the standard crops well, particularly wheat, which can be followed by barley of malting quality. The land grows good crops of swedes, and it is

not too heavy to admit of their being folded off with sheep. Mayweed (*Anthemis cotula* L.), Charlock or Kinkle (*Sinapis arvensis* L.), and true Couch (*Triticum repens* L.), with Sow Thistles (*Sonchus* sp.), Thistles (*Carduus* sp.), and Docks (*Rumex* sp.) are the most troublesome weeds, but Chickweed (*Stellaria media*), Groundsel (*Senecio vulgaris* L.), Fat Hen (*Chenopodium album* L.), and Knot Grass (*Polyganum aviculare* L.) are common.

The maritime district, often called the garden of Sussex, is equally famous for its fertility. Marshall described it as "the most good wheat land and on the whole the most valuable arable district of equal extent in the Island," and Farncombe, writing in 1850, says that much of the land was estimated as yielding five quarters of wheat for tithe commutation purposes, and that the Swedes were so good that on some farms neither cake nor corn was fed. The subsoils vary very greatly within a small area; white and red clays, red sand and white, and chalky marl may all be seen along the course of a single drain. Large flints occur, but the rounded black pebbles characteristic of the Thanet beds are not found. Most of the land is under arable cultivation, though there is some pasture of a rather ordinary character along the water courses. As will be seen from the map (Fig. 45), wheat is perhaps the principal crop; five quarters are regularly grown, some farms average six, and seven quarters are commonly spoken of. Oats are much grown after the roots, but barley is mostly confined to the Coombe rock. A common rotation consists in taking two corn crops after the roots folded off, then clover followed by two more white straw crops. Vetches are often fed off and followed by mangolds; while in some places when the oat crop can be harvested early trefoil is sown, and after a short growth is ploughed in as a preparation for wheat. Owing to favourable climatic conditions the harvests are early, while the dense corn crops keep down the weeds. Sufficient cleaning can be done during September and October to ensure the success of the second corn crop. The straw is stiff and well set with grain, and crops will stand here which on other formations would be laid.

Potatoes and other special crops are but little grown, and the mainstay of the farming, after the sale of corn, is the fattening of stock. The land will permit of sheep being folded upon it in the winter, and large numbers of tegs are brought down from the South Downs or from the west country to be fattened. On the lighter lands near the hill a good many early lambs are reared from Dorset horn ewes crossed with a Down ram, rye and vetches being grown as early keep for the ewes and lambs. Devon cattle are also bought in for fattening in the yards.

It is on this brick earth from Lancing westwards, and especially in the neighbourhood of Worthing, that so much cultivation under glass is carried on, the whole industry being of comparatively recent growth. The chief crops are grapes, tomatoes, cucumbers, and forced strawberries, and the Worthing growers have achieved a high reputation for the quality and finish of their produce.

Composition of the Brick Earths.—Turning to the analyses it will be seen that in Kent the Brick Earths give rise to a very uniform set of soils which are devoid of stone and contain very

little fine gravel or coarse sand, but the next two fractions—the fine sand and the silt—constitute almost exactly two-thirds of the whole soil, sometimes the sand, but generally the silt, being the greater. The fine silt is very constant, between 8 and 10 per cent., and the clay between 10 and 15 per cent. The subsoil is, as usual, a little heavier than the soil, containing a little more clay and fine silt, but there is very little difference between soil and subsoil in these alluvials, much less than in many soils.

The Sussex Brick Earth is very similar in mechanical composition to that in Kent, though on the whole it is a trifle heavier, the difference being less seen in the clay than in the fine silt, which is distinctly higher in the Sussex than in the Kent soils. The Shopwyke soil, No. 207, is taken from the valley gravel or Coombe rock, but the chief feature which distinguishes it from the other soils is its stony nature, the soil between the stones being much the same. All the Sussex Brick Earths contain some stone, more than do the Kent soils.

The distinguishing feature of these analyses is the even distribution of the various grades of particles below the coarse sand limit; the soils are on the whole fine grained, but silt and fine sand predominate and not clay, and in consequence they drain freely and yet can lift water back by capillarity in seasons of drought. Thus they will keep crops growing during droughts which cause the plants to suffer severely on soils which have a much greater water-holding capacity but which do not admit of much capillary rise. Both in Kent and Sussex dry seasons rather than wet are preferred for these soils. The Brick Earth soils all dry quickly and do not tend to cake on the surface after drying.

From the chemical point of view the Brick Earth soils, like the more recent alluvials, are apt to be short of carbonate of lime; in the past they have very generally been dressed with the chalk which is not far away, and lime is always reported to do good. Indeed, in some cases it is necessary, for "finger-and-toe" or club root in turnips is not uncommon in either Sussex or Kent. Near the sea in the maritime part of Sussex a bed of marl can be reached a few feet below the surface, and the use of this in the past has done much to ameliorate the soils. Names like "Marl-pit Lane" and "Marl-pit Field" are still common though the pits are no longer open. Being arable soils, the proportion of organic matter and nitrogen is never so high as in the alluvial soils previously described, but the nitrogen is still very high on the average, even allowing for the fact that some of the soils are taken from hop-gardens. The nitrogen is also high in the subsoils, again a sign of the alluvial origin of the formation, the deposit being made up of material originally washed from other soils. The proportion of potash is very constant, from 0·3 to 0·4 per cent., and there is generally as much, or a little more, in the subsoil. The available potash is high, about 10 per cent. of the total. Magnesia lies between 0·3 and 0·5 per cent., and is always less than the lime. Alumina, as usual, amounts to about one-third of the clay, and the ferric oxide is a little less, about 2·5 per cent., but ferrous compounds are rarely found. Some manganese is always present, about 0·04 per cent.

The proportion of phosphoric acid is high, varying from 0·10 to 0·25 per cent., probably on account of the high cultivation and manuring these soils have received. In the subsoil also it is considerably above the general average. The available phosphoric acid is also exceptionally high in amount, being over 10 and often as much as 20 per cent. of the total phosphoric acid. The sulphuric acid is low, about 0·05 per cent.

Manuring of the Brick Earth.—The manuring required for these soils is of a general character, dictated by the kind of crop; for hops and fruit organic manures like shoddy, fish and meat guanos, and rape dust are in favour, and act quickly in the warm, well-worked soil. Superphosphate is the most suitable phosphatic manure for swedes, except where there is danger of "finger-and-toe," in which case a neutral phosphate like steamed bone-flour or phosphatic guano should be employed. Basic slag does well on the Sussex Brick Earths, but the East Kent soils are too dry to make it a success there. The Sussex Brick Earth is benefited by liming. Sulphate of ammonia, ordinarily a good active nitrogenous fertiliser for these soils, should also be avoided where "finger-and-toe" prevails, or used in mixture with nitrate of soda. Potash manures are rarely necessary; even for the mangold crop a dressing of salt will generally liberate enough of the potash in the soil.

This land is rarely laid down to permanent grass, but if a seeds mixture is required for that purpose the one recommended for the Clay-with-Flints (p. 78) will serve very well. For one year leys red clover can only be taken once in six, seven, or eight years, so in the alternate occasions when the seeds come round, either trefoil, alsike, or sainfoin should be sown, the two latter with rye grass; or a crop of winter vetches for hay could be followed by mustard or rape to be eaten off. Lucerne will also grow well on this land, which should be well limed before the seed is sown.

3. The Clay-with-Flints.

Origin and Distribution of the Clay-with-Flints.—It has already been mentioned that when the southern facing scarp of the North Downs is ascended there will be found a comparatively flat plateau country, sloping very gently to the north and east, and covered with a pretty stiff formation of reddish clay in which numbers of large flints are to be found.

The greater part of the chalk area from Guildford eastwards to Canterbury is covered by the Clay-with-Flints, with the exception of certain stretches of bare chalk like the Epsom Downs and the sides and bottoms of the many valleys, generally dry, which run down the dip slope at right angles to the general line of the North Downs and cut deeply into the plateau. On the sides of these valleys the chalk has been bared and is only covered by the usual thin loam found where the chalk is not obscured by superficial deposits; in the bottoms of the valleys there are generally great accumulations of flint stones to represent the Clay-with-Flints that has been washed away. Along the promontories of chalk, protruding far into the low country between the dry valleys that ridge the northern slope of the downs, stretch narrow

tongues of the Clay-with-Flints, which in the country between Chatham and Faversham get inextricably confused with the patches of Thanet Sand and Brick Earth also overlying the Chalk at the lower levels. In Kent, east of the Stour, the Clay with Flints is pretty well confined to the plateau lying between the escarpment and the Elham Valley; the Upper Chalk to the eastward and the Isle of Thanet being only covered with a loam, often deep but presenting none of the distinctive features of the Clay-with-Flints. On the South Downs the Clay-with-Flints is also absent except for a few small patches.

The escarpment is usually formed of the Middle and Lower Chalk—the grey chalk without flints, the Upper White Chalk with flints having as a rule been denuded away near the edge of the escarpment, and as the Clay-with-Flints belong to no definite formation and possesses no sign of stratification it is often regarded as the undissolved portion of the original mass of Upper Chalk, which must have overlain the chalk rock as seen to-day on the plateau. Now the Upper White Chalk was originally about 500 feet thick, it has a density of 1·6, and, in addition to its flints, it contains about 1·2 per cent. of clay-like material insoluble in dilute acids, which in the laboratory attack the calcium carbonate and leave behind much the same material as water charged with carbonic acid would do in nature. The Clay-with-Flints has *in situ* a density of about 1·9, so that assuming it to represent the undissolved residue of the chalk it would take about 100 feet of chalk to make a foot of Clay-with-Flints, leaving out of account the actual flint stones, which are not likely to add more than 10 per cent. to the space occupied by the clay itself.

The thickness of the Clay-with-Flints is rather difficult to estimate, because the surface of the chalk below is always very irregular and much let down into pipes and drainage channels, but in many places on the North Kent plateau the clay cannot average less than 15 feet thick. Such a thickness, even if no allowance were made for later surface denudation, would imply at least 1,500 feet of chalk removed, whereas not more than 500 are supposed to have existed.* It is therefore necessary to assume that some other formations as well as the Chalk went to the making of the Clay-with-Flints, and the probability is that the lower more loamy strata of the Thanet Sands contributed. In many parts of the Clay-with-Flints, especially in Surrey, the clay becomes distinctly loamy and even shows inclusions of almost pure sand; in Hertfordshire again, where a thick Clay-with-Flints caps the Chalk there can be seen in the subsoil blocks of undoubted Thanet Sand, in which the original stratification has not been entirely obliterated. As, however, the rounded black flint pebbles, so characteristic of the higher Thanet beds, are rarely found in the Clay-with-Flints, no strata above the lower Thanet beds can have contributed to its formation. Under what conditions the Clay-with-Flints was formed it is difficult to surmise; it has clearly never undergone the sorting action of running water, its flints are unworn, and it lies only on the very caps of

* *See also* A. J. Jukes-Browne. *Quart. Jour. Geol. Soc.*, 1906, 62, 132.

the hills and along the top of the plateaux, for on the sides of the slopes and in the valleys it has been thinned down or denuded away. Whatever its origin the Clay-with-Flints forms a bed of stiff sandy clay in which flints of all sizes are irregularly scattered; below the surface it has a pronounced reddish colour, and where it rests on the irregular surface of the chalk there is generally to be seen a thin chocolate-coloured layer of polished clay, in which a good deal of oxide of manganese can be detected.

Agriculture on the Clay-with-Flints.—At the surface the Clay-with-Flints give rise to dull reddish soil, of a distinctly clay-like character, very wet and sticky in the winter and drying in the summer to hard intractable clods. The surface is covered with flint stones of all sizes which help both to drain and warm the soil, but they increase the labour of horses on the land and are very destructive of ploughs and cultivators. Only a small proportion, however, of the surface of the Clay-with-Flints is under the plough, but much is in woodland, and it is in fact the presence of this stubborn soil which accounts for the comparatively wooded aspect of the North Downs, especially near the escarpment.

In Surrey the Downs from Guildford to the Mole Valley are heavily wooded, but as the map shows (Fig. 55) there is then less wood until the neighbourhood of Knockholt is reached, whence there is a long line of big woods near the edge of the escarpment, the most extensive being perhaps the Kingswood that stretches from above Lenham to the Stour Valley. East of the Stour, between Wye, the Elham Valley, and Folkestone, the chalk is very generally covered by the Clay-with-Flints, and the woodlands are there most extensive, diversified by open unenclosed heaths or "minnises," clothed with gorse and bracken. The typical management is oak over copse, the copse wood being generally chestnut which is cut over for hop poles on a 14 to 18 years' lease. Ash and birch are also common in the underwood, with a good proportion of hornbeam, but the situation is apt to be too dry for ash. Besides oak a good deal of beech timber is to be seen, but that is where the clay is rather lighter and thinner.

Of cleared land, much that was at one time in arable cultivation has sunk down to a state of poor pasture; only those portions well back from the escarpment where the height above sea level has dropped considerably still remain under the plough. The typical Clay-with-Flints land is stiff and intractable and not particularly productive at such heights as 400 to 600 feet above sea level, and it has in consequence gone back to grass, though with careful farming and manure it will yield excellent crops of corn and especially of wheat. The small value of the soil comes from its wetness and stickiness in winter, and its consequent lateness (this also depends upon the altitude); it is impossible to fold sheep upon it in the winter, and it requires considerable skill in handling to secure a good tilth. At lower elevations, however, when well managed and liberally manured, it grows good corn and bean crops, and both mangolds and turnips, the latter suffering less from mildew than on the lighter and hotter soils. The

turnips should be drawn off the land; sometimes sheep are folded upon the stubbles, the roots being brought to them in order to avoid the risk of poaching the land too much. On the better soils of this type, as in the Faversham and Sittingbourne districts, where the Clay-with-Flints extends into the highly-farmed country, a rotation of roots, oats, seeds, wheat, and barley is often followed, the dung being applied before the wheat. In this district some hops are grown in the Clay-with-Flints, though the soil has reached nearly the limiting degree of heaviness for hops; fruit also does well, especially apples and cherries, if the land is properly managed at first and the trees are given a good start. The most troublesome weeds on this formation are Charlock (*Sinapis arvensis* L.), Black Bent Grass (*Alopecurus agrestis* L.) often called Couch Grass, though the true Couch (*Triticum repens* L.) also occurs on this land, Sow Thistles (particularly *Sonchus arvensis* L.), Bindweed (*Convolvulus arvensis* L.), and the Docks, Thistles, and Poppies that are common to most soils.

Composition of the Clay-with-Flints.—An examination of the mechanical analyses shows that these soils are not unlike the Brick Earths previously described, though they are of a distinctly heavier type and much more variable among themselves. All the Surrey examples and one of the Kentish soils contain considerable quantities of coarse sand, ranging from 4 to 14 per cent., but the fine sand is generally the largest fraction, ranging from 20 to 34 per cent. The silt is about equally large; the fine silt amounts to about 10 per cent., while the clay ranges from about 11 per cent. to as much as 30 per cent., 16 per cent. being about the average. Though the mechanical analyses vary so much, it is still possible to recognise these soils as belonging to a common type; the Rothamsted soil, which is similarly situated on the chalk plateau in Hertfordshire, is very similar and falls into line with them. It is noteworthy that these soils are all considerably lighter than their subsoils, the differences in the proportion of clay being in many cases exceptionally large.

As regards the chemical analyses, one of the most striking features is the small proportion of lime; considering that the soils have been largely formed out of the Chalk and rest upon it, it is remarkable how thoroughly they have been decalcified. When walking about the diversified country on the top of the North Downs the Clay-with-Flints can at once be recognised by the sudden cessation of the chalk plants and their replacement by distinct calcifuges. The foxglove is a very good test plant in this way as it never strays on to land containing much calcium carbonate; gorse and broom are also characteristic, mixed usually with bracken. Heather is rare in the East Kent area, but it is common on the corresponding but more sandy soils of Surrey, *e.g.*, on Walton Heath. Spanish Chestnut and hornbeam in the woodlands are also characteristic calcifuge trees. The lack of lime has a very injurious effect upon the texture of these soils, and lime or chalk is absolutely necessary if they are to be kept working freely under the plough. In the eighteenth century and earlier it was part of the regular routine of farming on these soils to sink pits through the clay and bring up chalk

to be spread over the fields, and most of the arable land that works easily at the present time will be found to have been so thoroughly chalked at some earlier date that it still contains one per cent. or more of carbonate of lime. In Hertfordshire on the Rothamsted estate this chalking process, which has been discontinued since the early years of the nineteenth century, has left from 2 to 5 per cent. of carbonate of lime in the surface soil, and it has been shown that the fields which were passed over when the chalking was done are not now fit for arable cultivation, but have gone down to grass of the poorest quality, so wet and stiff is the land.

Among the soils under review it will be noticed that Nos. 159, 155, and 110 have each got more than 1 per cent. of calcium carbonate in the surface soil, and that it is of artificial origin may be inferred from the fact that there is more in the surface soil than in the subsoil. Nos. 137, 180, 109, 108, and 111 have about half a per cent. and have doubtless been chalked or limed; the natural untouched soil is seen in Nos. 157, 153, and 135, where there is less than one-tenth per cent. in either soil or subsoil. A good example of the value of chalking is afforded by soils Nos. 109 and 110, which are taken from adjoining fields; No. 109 is reputed to be the stiffest soil in the district, easily gets water-logged and has been laid down to grass, whereas No. 110 is kept in arable and yields good crops. The mechanical analyses show that No. 110 is really slightly the heavier soil of the two, but it contains 1·08 per cent. and 0·28 per cent. of calcium carbonate in soil and subsoil respectively, while No. 109 only contains 0·48 and 0·08 per cent. It is the presence of the extra carbonate of lime in No. 110 which keeps the soil open and friable.

The soils from the Clay-with-Flints show about an average amount of organic matter and nitrogen; the figures are rather high for arable soils, but the texture is heavy and the soils generally cool, both factors which tend towards the preservation of organic matter. In the subsoils also the proportion of nitrogen is rather high, up to 0·13 per cent. The potash is very constant in amount, ranging from 0·35 to 0·4 per cent., a little more being present in the subsoils. The available potash is fairly high, amounting to about 10 per cent. of the total potash, though in the Surrey soils it is more nearly 5 per cent. The magnesia varies between 0·3 and 0·5 per cent., being generally lower than the lime. Alumina, as usual, varies with the clay and constitutes from 5 to 6 per cent. of the soil. The ferric oxide falls usually between 3 and 5 per cent., and only in one case was ferrous iron noticed. Manganese is present in comparatively large amounts; with one exception about 0·1 per cent. is found. The phosphoric acid is, on the whole, rather low, from 0·10 to 0·13 per cent., with less in the subsoil, but the available phosphoric acid is generally more than 10 per cent. of the total, and ranges from 0·01 to 0·02 per cent. General experience shows that phosphatic manures are necessary on these soils. The sulphuric acid calls for no comment, being pretty constant at about 0·05 per cent.

Manuring of the Clay-with-Flints.—It has already been indicated that all these soils should be periodically limed or chalked;

the best plan is to give them about a ton of quicklime per acre once during each rotation, spreading it after slaking on the stubble before ploughing this up for roots. If ground lime can be obtained and sown by machine, half a ton per acre will suffice. Even where some lime or chalk has been used in the past it is necessary to renew the application, because the rain water draining through the soil is always removing some of the lime. On the similar soils at Rothamsted it is found that the carbonate of lime is being removed from the surface soil at the rate of about 800 lb. of carbonate of lime per acre per annum, and the use of fertilisers like sulphate of ammonia increases the rate of loss.

Farmyard manure is especially valuable on this stubborn soil; as far as possible it should be taken out of the yards long and green and ploughed into the land before the winter sets in. It is not customary in East Kent to dung for the swedes, because it is found to "let the drought" into the land too much; as a rule, the dung is spread on the old seeds layer and ploughed in before the wheat.

Of the phosphatic manures basic slag has proved to be valuable, particularly so where the land is deficient in lime, but where the land has been chalked superphosphate will give better returns, as the climate is a little dry to enable basic slag to exert its best effects.

Potassic manures have been found useful for the mangold crop, but are not required anywhere else in the rotation; even with mangolds the use of nitrate of soda as a source of nitrogen, mixed with salt, will generally liberate enough potash from the soil to obviate the need for direct potash manuring. The kind of dressings recommended are:—

For swede turnips without dung—

4 cwt. per acre, superphosphate or basic slag.
1 cwt. per acre, fish guano.
1/2 cwt. per acre, sulphate of ammonia.

The superphosphate and sulphate of ammonia should only be used where the soil contains some carbonate of lime.

For mangolds:—

10 tons farmyard manure 2 cwt. superphosphate	before the seed.
2 cwt. nitrate of soda 2 cwt. salt	as a top dressing.

For barley, after wheat, if the land is not in very good condition, 3 cwt. of superphosphate and 2 cwt. of rape-dust makes a good manure, but good barley can only be grown on the lower levels.

As to seed mixtures, red clover is not good when it is taken more frequently than one year in seven; a mixture of about 20 lb. of broad-leaved red clover and 4 lb. of rye grass should be alternated with a mixture of 2 bushels unmilled sainfoin, 5 lb. of Alsike clover, and 3 lb. of Italian rye grass when the seeds come round again in the rotation. This succeeds on the lower and better soils, but on the stiffest and coldest clays it is better to

adopt a rotation in which the seeds are left down for three years or so, and sow a mixture of the following order:—

	lb.
Perennial red clover	3
Alsike	3
White clover	2
Italian rye grass	5
Perennial rye grass	5
Timothy	2
Cocksfoot	3
Meadow fescue	2
	25

For permanent pasture the following mixture answers:—

	lb.
Perennial red clover	2
Alsike	3
White clover	2
Meadow foxtail	5
Cocksfoot	5
Tall oat grass (*A. elatior*)	3
Meadow fescue	3
Perennial rye grass	5
Rough-stalked meadow grass	2
Timothy	2

Lucerne can be grown successfully on the Clay-with-Flints, but the land should be well prepared and limed beforehand; it will rarely stand more than five years, as it becomes choked with the creeping *Agrostis* or bent grass.

On some parts of the Downs between Lenham and Folkestone small patches of reddish sand occur near the edge of the escarpment; these have been identified as a particular tertiary formation, represented elsewhere in Belgium and by a small patch in Cornwall. They have been called the Lenham Sands, but they possess no agricultural importance, being so elevated that they are only covered by either poor grass or woodland.

4. The Bagshot Beds.

Distribution of the Bagshot Beds.—The most recent geological formation possessing any considerable outcrop in the south-eastern area is known as the Bagshot Beds, a series of sandy strata which owe their name to the village of Bagshot in north-west Surrey, a district that is mostly covered by these beds. Geologically the Bagshot Sands are divided into upper, middle, and lower beds, but the whole series is so much alike lithologically that the classification possesses little agricultural significance; from top to bottom of the formation the same coarse sandy material occurs with occasional thin partings of finer sandy clay either yellowish, red, or blue, and locally called "blue slip." The upper and middle beds often form hills, with a slightly scarped face to the southward; the Lower Bagshot Beds occupy

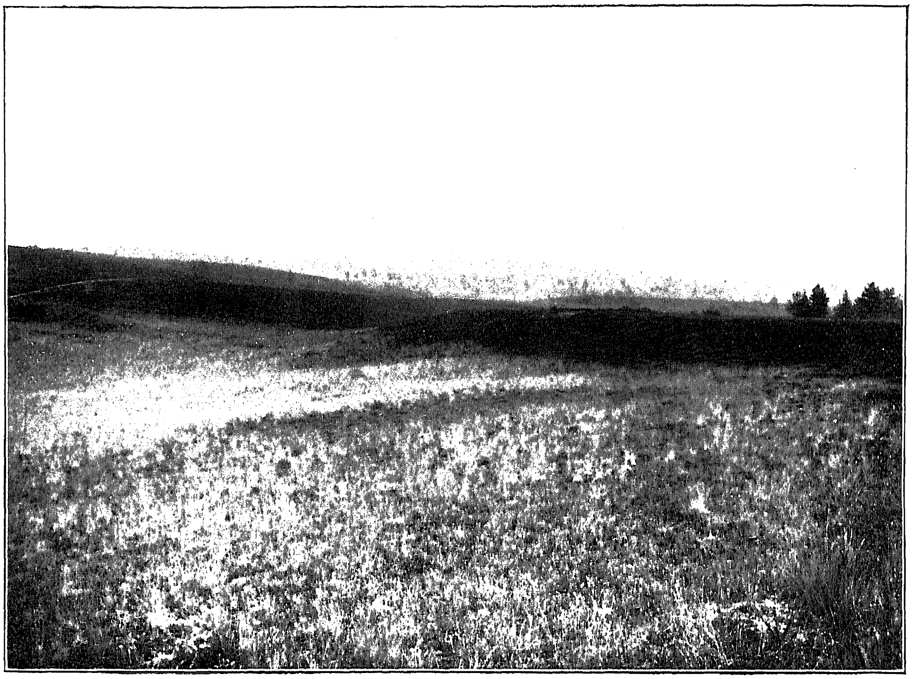


Fig. 28.—Barren Bagshot Sands near Bagshot.

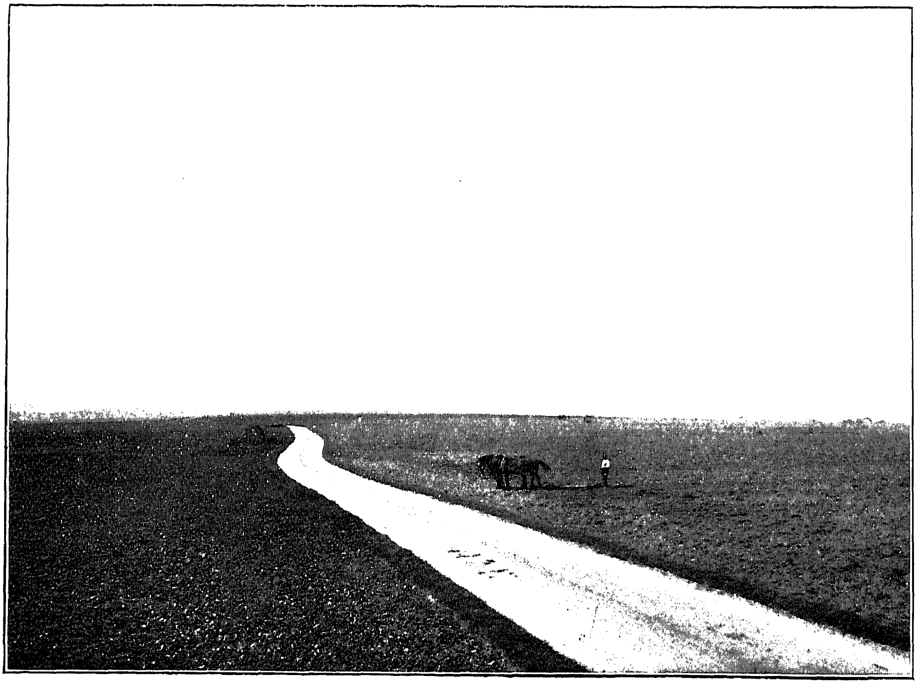


Fig. 29.—Open Cultivated Chalk Country, Minster, Thanet.

(*To face p.* 79.)

the valley, and as they receive the drainage from the higher beds they are more often in cultivation, or even carry pasture by the stream sides.

In Kent the Bagshots are only to be recognised as a thin cap of lighter material upon the London Clay in the Isle of Sheppey, and it is not until Wimbledon Hill is reached that another such cap can be recognised. From thence westwards the Bagshots form a gradually widening wedge shaped area; at first only outliers appear upon the London Clay, sometimes as extensive areas like Esher and Oxshott Commons, sometimes as a barely recognisable stratum merely lightening the London Clay below, until west of the Wey the main area begins and nothing else is seen until the county boundary is reached. From Clandon to Weybridge the Bagshots are much intermixed with patches of alluvium brought by the Mole and the Wey, as at Horsham, Byfleet, and Chobham. The alluvium is generally occupied by market gardeners and fruit growers, the Bagshots are either open heath or golf links. Southward the boundary is formed by the breadth of London Clay which lies at the foot of the Chalk Downs, and at the junction of the sand and clay some very good soils occur. The Bagshots then continue into Hampshire and Berkshire, forming the great extent of heaths round Aldershot, Ascot, and Windsor Forest, almost as far up the Thames Valley as Reading.

The Bagshot country is all of much the same character: it consists of barren open heaths, covered with heather and tussocky grass, though big patches occur bare of vegetation and show a black peaty surface through which white bleached sand (Cobbett's "spuey sand") breaks through in places. Extensive plantations of Scotch Fir and other conifers are to be seen; the Scotch Fir sows itself and will creep over the heaths if allowed to do so. Fig. 28 shows a characteristic view.

Agriculture on the Bagshot Beds.—For more than a century the dryness of the soil and the ease of finding water has made the district a favourite one for residential purposes, while the establishment of the Aldershot Camp, the Military College at Sandhurst, and the Staff College at Camberley, have also contributed to the growth of a residential population. A large proportion of the Bagshot area is common land and much that was still unenclosed has been bought up by the War Office from time to time, so that the agricultural land in this area is not important. The soil has remained heath and common simply because it has always been too poor to be worth enclosing and cultivating; only near the bottoms of the valleys where a little deeper soil has accumulated, or on certain areas where the soil is not quite so light as usual, has cultivation sprung up, but thanks to the liberal use of London dung, street refuse and the like, the barren sands have in many cases been transformed into useful land, especially for market garden purposes. Very often, however, the small farms—originally squatters' seizures—are wretched affairs of poor arable land on the sides of the valleys, with some miserable grass land along the streams, and the occupiers only make a living because there are good markets in

the houses round about for everything that can be sold off the farm, such as hay, straw, oats, milk, eggs, and chickens.

The natural vegetation of the Bagshot Sands is determined by two factors—the entire lack of lime in the soil and its extreme dryness. The soil being almost entirely composed of sand the rainfall percolates with great rapidity; the coarse-textured soil itself possesses a very small water-holding capacity and cannot lift water to any extent by capillarity, and the only wet patches in the area are where the partings of clay or the iron pan holds up the water near the surface, in which case peat at once begins to accumulate owing to the absence of lime. On the heaths the absence of lime and the acidity of the soil result in the bleaching of the otherwise rusty-coloured sand for a foot or more below the surface; below the bleached sand a hard black layer, half-an-inch or more in thickness, containing oxides of iron and manganese is always found and in some places it may get so consolidated that it seriously interferes with the drainage and creates a boggy spot. In places the Lower Bagshots are kept water-logged because they rest on a saucer-like depression in the London Clay below them, as on Clandon Common; in such cases acid conditions and the formation of peat rapidly set in.

On the open land the most characteristic plant is the Heather (*Calluna vulgaris,* Salisb.), but both the Bell and the Cross-leaved Heaths (*Erica cinerea,* L. and *Erica Tetralix,* L.) are also found. Associated with the heaths are the Creeping Willow (*Salix repens,* L.), the small prickly or Needle Furze (*Genista anglica,* L.) and Bracken (*Pteris aquilina,* L.). Gorse is very general and Foxgloves occur everywhere; Tormentil, Sorrel, Silver-weed, various Agarics and Mosses with Cotton Grass, Sedges, and Bog Asphodel in the wet places, are also characteristic, as also the generally tufted habit of the grasses, *Molinia coerulea,* Mœnch, *Agrostis alba,* L., and Sheep's Fescue in particular. The characteristic trees are Scotch Fir and Austrian Pine, but all kinds of Conifers are planted for ornamental purposes and flourish; Birches are common on the edges of the heaths, and Spanish Chestnut is planted in places. Hollies flourish, as do Rhododendrons and all their allies.

Although the farming on the Bagshot Sands is not of very great importance there are three distinct types of holding. In the first place there are the intensively cultivated market garden farms on the patches of Bagshot Sand in the valleys of the Thames and of the Wey and Mole, near Esher, Old Woking, Chertsey, and Windlesham; all farms which keep few or no stock, but sell everything off, growing Brussels sprouts, broccoli, peas, runner beans, carrots, potatoes, and similar crops, and trusting largely to purchased dung for their manure. These farms are partly on the Bagshot beds and partly on the alluvials, which, however, are in this region hardly to be distinguished from the former in texture and composition, as for example Nos. 189, 295-7, described under the alluvials. It is noteworthy that these farms are to some extent dropping market gardening in consequence of the low prices that have ruled of late years for vegetables, and instead are taking to mixed farming and corn growing, especially

as the neighbourhood affords a good market for straw. The land is now in high condition as a result of the market gardening, and as it is very easy to work, good crops of corn can be grown exceedingly cheaply if the spring and summer do not prove too dry; the manuring, however, must be kept up, as this land yields miserable crops if allowed to fall back into its natural poor condition. The size of the crop largely depends on the season. The most favourable weather conditions are dry winters, warm springs, and showery summers. Milch cows are being increasingly kept on the green-soiling system, but sheep are rarely seen.

Besides this intensive farming, which is or was mostly bound up with market gardening, there are, especially towards the western boundary of the county, many small farms of the poorest type, where the outlay necessary to create a soil on this type of land has never been made. As has been said before these farms depend upon sales to the residents near, carting, and so forth.

Thirdly, the Bagshot Beds are largely occupied by nursery gardens, which stretch in almost a continuous line from Old Woking to the county boundary; there a very large proportion of the stocks for fruit trees, and the ornamental shrubs and conifers, sold in this country, are propagated. Forest trees, fruit trees, and roses are largely raised elsewhere, but with these exceptions most of the general trade nursery stock of the country comes from this district. The warm early soil, which can be worked in almost any conditions of weather, and the way its open sandy character stimulates the production of fibrous roots, account for the location of the nurseries on this soil. There is also a certain amount of strawberry growing in the Thames Valley.

The Bagshot sand under cultivation is, like all light soils, extremely subject to weeds, as a rule quickly growing annuals, several of which are indicative of the acid nature of the soil. The most troublesome are the Corn Marigold (*Chrysanthemum segetum*, L.) locally named "yellowby," Sheep's Sorrel (*Rumex Acetosella*, L.), Spurrey (*Spergula arvensis*, L.) locally termed "dodder," Wire-weed (*Polygonum bistorta*), Couch (*Triticum repens*, L.), "Water grass" (*Agrostis alba*, L.), and a tall form of *Agrostis stolonifera* which is exceedingly abundant in the corn wherever the land is inclined to be wet below.

The pastures are poor, largely composed of tufted grasses like Sheep's Fescue (*Festuca ovina*, L.), and Bent (*Agrostis alba*, L.), while Sweet Vernal grass (*Anthoxanthum odoratum*, L.), Crested Dogstail (*Cynosurus cristatus*, L.), and Yorkshire Fog (*Holcus lanatus*, L.) are also abundant. The chief leguminous plants are Bird's Foot Trefoil, (*Lotus corniculatus*, L.), and the Hairy Vetch (*Vicia Cracca*, L.).

Composition of the Bagshot Beds.—In the mechanical analysis of the soils from the Bagshot Beds the most striking feature is the predominance of the sand fractions: from 70 to 80 per cent of the soils consists of these, the finer fraction being the more abundant. There is but little material coarser than the coarse sand, and the finest fractions, especially the clay, are always small; No. 91, a sample of uncultivated Upper Bagshot, at Brookwood, is the lightest soil that has fallen under our examination.

Chemically the soils are marked by a great lack of soluble mineral matter; calcium carbonate is practically absent,

except in one case where it has evidently accumulated as the result of past manuring. Potash is low, 0·2 to 0·3 per cent, though rather higher than might have been expected from the small proportions of clay. In one particular case, No. 90, the amount of potash is, however, exceptionally high, 1·4 per cent, in the surface, and 1·8 per cent in the subsoil; doubtless in this case the soil has been derived from some highly glauconitic layer in the formation. Magnesia is present in average amounts, 0·2 to 0·4 per cent. Alumina is naturally low, there being so little clay in the soil; oxide of iron also is generally lower than would have been expected, 0·5 to 2 per cent, while only small traces of manganese are to be found. Phosphoric acid is exceptionally low, never reaching 0·1 per cent, and is lower still in the subsoil; comparatively the citric-acid-soluble phosphoric acid is more nearly normal, which must be correlated with the generally acid reaction of the soil. Sulphuric acid is present in the usual proportions, about 0·03 per cent of the soil. The nitrogen is comparatively high and bears a relatively high proportion to the organic matter.

Manuring of the Bagshot Beds.—The usual manuring on these Bagshot soils has been confined to dung, so readily obtainable from London, but essential as is the organic matter in order to bind together the coarse particles of the soil and give it some water-holding capacity, something more than dung is wanted to make the best of the soil. In the first place lime or chalk must be used, and the acidity of the soil neutralised: chalk is better than lime on such soils, though it is slower in action and more costly in freight. With the line of the North Downs so near at hand, however, it should not be expensive to apply heavy dressings of chalk. If lime must be used, small quantities often applied should be the aim of the farmer; a large dressing of lime will depress the productiveness at first. Either chalk or lime should be put on in early spring before the land is broken up, preferably before the turnip crop. In some places in this district a sewage sludge rich in lime is procurable and will do much to improve the land, though its action is slow.

Besides lime the mineral manures should always be used with root and leafy crops. With regard to phosphates the land is too dry for basic slag and too sour for superphosphate; the best effects will be got out of such neutral phosphates as steamed bone flour and phosphatic guano. On this sandy soil potassic manures are greatly needed, but should be applied only a short time before the crop is sown, and sulphate of potash is preferable to kainit. Salt was formerly used for the grass land, but kainit is more beneficial. When an active nitrogenous manure is needed nitrate of soda should be chosen in preference to sulphate of ammonia.

Examples of Manuring:—

Swedes, turnips, cabbage, sprouts, broccoli, &c.—

10 tons dung.
3 cwt. steamed bone flour.
1 cwt. sulphate of potash.
1 cwt. meat or fish guano.

The greens, but not the turnips, may also receive 1 to 2 cwt. per acre of nitrate of soda.

Peas, runner beans, &c.—

3 cwt. phosphatic guano } before sowing.
1 cwt. sulphate of potash }

Much potash makes peas late, and so while increasing the yield may bring about a loss of profit; early peas should, therefore, have no potash, but plenty of phosphate and some nitrate of soda when the haulm is growing.

Barley and other cereals will generally be grown on land that has been manured for the preceding crop, but when clover is to be sown in the corn the land should receive the dressing specified for peas and beans before the corn is sown.

Too much stress cannot be laid on the necessity of early sowing on these soils, and the manuring should only just precede the sowing. Careful judgment is required in sowing market garden crops: if they go in too soon they suffer from frost, if too late they are killed by drought. As the soils are so light, and possess so little power of retaining manure, they should be kept covered with a crop during winter and only ploughed in early spring.

Good grass land on these soils can only be maintained and kept up by a liberal use of manures, especially in the early years, in order to establish a good type of vegetation. It is of course impossible to make a profitable pasture on the uplands and dry slopes of the Bagshot Sands, but on the wetter bottoms careful manuring will do much to improve the yield and the quality of the grass. When the land is regularly hayed it should receive a dressing of 1 ton of ground lime at regular intervals of 4 or 5 years, and about 10 to 15 tons of farmyard manure at about the same interval, though not if the land is inclined to be peaty or boggy. In the years when no farmyard manure is applied 2 or 3 cwt. of bone meal and 3 cwt. of kainit should be given in the winter with 1 cwt. of nitrate of soda as a top dressing in spring. Salt was formerly used for the grass land, but kainit is more beneficial. For pasture land the lime, kainit, and bone meal should be used every four years or so. When residents on the Bagshot Sands are anxious to obtain some nice grass land without much regard to cost the process should begin with liming and the application of bone meal and kainit; white clover should be sown (about 10 lb. per acre) in the early spring and harrowed in, and a little nitrate of soda may be sown later, even when the land is being grazed provided the stock are kept off until rain has washed the nitrate into the ground. After three or four years of this treatment a good dressing of dung may be given and the land hayed, but at first, until the vegetation has been a little reformed, dung and heavy cake feeding rather tend to deteriorate the herbage.

5. The London Clay.

Distribution of the London Clay.—In Kent the London Clay is somewhat irregularly distributed; it occupies a large tract of country immediately to the north of Canterbury, known as the Blean, which stretches from Thanet as far west as Dunkirk and comes down to the coast at Herne Bay and Whitstable. The greater part of the Island of Sheppey is on the London Clay, as also is much of the land in the Hundred of Hoo. In the neighbourhood

of London the London Clay caps many of the hills about Beckenham and Bromley; further west in suburban Surrey it is the chief formation, though much obscured by the valley gravels of the Thames and Wandle. It occupies a considerable tract of low country south and west of Wimbledon on to Epsom and Leatherhead; a great part of Richmond Park is on the London Clay, which also extends some distance up the Wimbledon Hill. The South-Western new line to Guildford mostly follows the broad valley formed by the London Clay, and again the line between Guildford and Ash runs along a similar though narrower outcrop of the same formation.

Agriculture on the London Clay.—In general the London Clay is now in pasture; much of it was excellent strong wheat and bean land, but of late years it has gone down to grass. In many places, especially on the higher levels, it is woodland; some of it, such as the Blean Woods, near Canterbury, has probably never been anything else. The woods are mainly oak over copse, and grow good oak timber. Except in its highest beds the London Clay gives rise to a very stiff and intractable soil, both difficult and expensive to cultivate, though capable of yielding in favourable seasons heavy crops of grain and straw. Some of it forms excellent pasture, though when this is the case the surface soil has generally been lightened by some admixture of drift or of sand washed from the contiguous Bagshot Beds. It is in Surrey that the most cultivation will be seen on the London Clay; in the neighbourhood of Surbiton, Ewell, and Epsom, for example, the county is undulating, and on the higher ground there are actual patches of Bagshot Sand, while the London Clay itself becomes somewhat sandy in its uppermost beds.

In this district there are many farmers making a speciality of cow-keeping to supply milk, though some of them also grow potatoes and do market-gardening if the farm also includes a patch of Bagshot Sand or alluvial soil. The dairy farmers manure heavily and grow big crops, particularly of mangolds: they require large quantities of mangolds for winter feeding, and as the farms are not generally large they aim at obtaining very heavy crops, 50 to 60 tons per acre, by the help of London dung. The heavy land is ploughed in autumn, left fallow through the winter, 40 tons of London dung per acre are spread in March and ploughed in, and the land is well rolled. Sulphate of ammonia is also applied as a top dressing, though nitrate of soda would be more effective on such land where carbonate of lime is lacking. Both quicklime and gas lime are known to be effective in improving the working of the soil and in increasing its fertility.

The manure used is mostly London dung; the cow-keepers are not able to make as much as they should because the local dairy regulations insist on the complete drainage of all the cowstalls; as a consequence there is no proper treading down of the urine, fæces, and straw, and as a still further disadvantage the farmer on this heavy soil has the greatest difficulty in getting rid of the diluted urine of the drainage.

Such districts as part of the forest of Blean or Ashtead Common in Surrey show the unmixed London Clay at its worst;

undrained, sour, and cold, saturated all the winter and cracking wide during drought, it has little economic value except for timber. The inferior nature of the soil may be gauged from the extensive tracts of common land found on this formation in Surrey, *e.g.*, the commons of Claygate, Epsom, Ashtead, Ockham, East Clandon, and elsewhere, the existence of which may be taken to indicate that the land has never been considered worth enclosing. The well water in the London Clay is inferior, generally highly charged with mineral matter and especially with magnesium sulphate, which owes its trivial name of "Epsom Salts" to its occurrence in a well in the London Clay on Epsom Common. Where, however, the clay is capped with gravel or Bagshot Sands a good supply of surface water is generally to be obtained, the percolating rain water being held up by the clay and thrown out in springs at the junction of the beds. The London Clay by itself is, as a rule, too stiff for brick-making, except in the highest beds; in Surrey, however, it becomes more sandy, and there are several valuable brickyards, especially where more of the necessary sand is derived from the neighbouring Bagshot Beds.

Composition of the London Clay.—Reviewing the analyses in detail it will be seen that the samples taken from the eastern part of our area are much finer in texture and more "heavy" in the farmer's sense than those taken in West Surrey:—

	East Kent Limits.	West Surrey Limits.
Coarse sand	0·3 to 0·8	12·8 to 17·4
Fine sand	6·5 to 17·6	25·5 to 38·1
Silt	13·4 to 15·8	11·3 to 14·8
Fine silt	15·3 to 16·3	7·4 to 11·1
Clay	36·8 to 40·5	12·8 to 23·7

Not only is the proportion of the finest material very high in the East Kent samples, but the coarser sand is extremely deficient, being less than 1 per cent, while the Ashtead sample contains 5·5 per cent, and the Wanborough sample 17·4 per cent. It would be difficult to find heavier clays than the Blean and Sheppey specimens, whereas the West Surrey samples are little more than clay loams.

The London Clay soils are deficient in carbonate of lime, especially the more loamy soils in Surrey, where, with two exceptions, no soil contained as much as 0·4 per cent of this important constituent and the subsoils contained less. Sample No. 107 gave 2 per cent of carbonate of lime and No. 293 gave 1·6 per cent, and both seemed to have recently received a dressing of chalk; visible traces of liming or chalking were to be seen in the Blean and Sheppey soils.

There are few soils which may be more profitably dressed with quicklime than those resting upon the London Clay; many of them are sour; "finger and toe" is reported among the turnips in some districts; also lime is wanted to ameliorate the texture of all, and render the land less retentive of water.

As is usual with cold, close-textured soils, the proportion of organic matter and of nitrogen is high because the processes of decay are slow; material like farmyard manure is very persistent.

and there will even be an accumulation of peaty matter wherever the soil is undrained. The dressings of lime indicated above will also be of service in bringing the nitrogenous reserves of the soil more rapidly into action.

Phosphoric acid is often deficient in this group of soils, and the deficiency is even more marked in the loamy samples from Surrey than in the East Kent specimens. Five samples taken west of Guildford gave a mean percentage of ·065 per cent of phosphoric acid; the three mid-Surrey samples contain ·103 per cent; the two East Kent samples ·115 per cent. All are low, and the deficiency is equally marked in the figures obtained for "available" phosphoric acid by solution in 1 per cent citric acid.

It will be noticed that in all cases the subsoil is poorer in phosphoric acid than the surface soil; the deficiency is therefore due to the formation and inherent in the underlying material from which the soil is derived.

The proportion of potash is high, as is usually the case with clay soils; again, as might be expected, the heavier soils of the eastern area show the most potash, and the proportion decreases as we come to the more sandy soils of West Surrey. There is also more potash in the subsoils than in the surface soils; the two subsoils from the London Clay in East Kent show about 1·5 per cent of potash soluble in hydrochloric acid, as against less than 1·3 per cent in the corresponding surface soils.

Notwithstanding the richness of these soils in potash there is no very exceptional amount present in an "available" and easily soluble condition. This is particularly noticeable in the soil taken from Ashtead Common, which has never been under cultivation; the "available" potash is ·013 per cent, when the potash soluble in strong hydrochloric acid is ·76 per cent; the available phosphoric acid is also a very small fraction of the total phosphoric acid in this soil—·006 per cent. in ·093 per cent, or one-sixteenth only. The low availability of the mineral plant food in this poor pasture may be correlated both with the want of cultivation and the absence of lime, for the soil shows only a minute trace and the subsoil an entire absence of carbonate of lime.

The proportion of magnesia in all these soils is high, varying between ·35 per cent and 2·02 per cent; the sulphuric acid is not particularly abundant, showing that the magnesia must be present chiefly in combination as silicate. Manganese is comparatively abundant and accumulates in the bog iron ore, which forms whenever the drainage is deficient.

Manuring the London Clay.—The prime need of all these soils is lime; they are generally rich in nitrogen and potash, but both constituents are largely dormant and can only be brought into action by lime.

Quicklime is the best material for these soils, as it effects the quickest improvement in the texture of the clay, but the more loamy London Clay soils of West Surrey may with advantage be chalked with the soft white chalk obtainable from the neighbouring Hog's Back. In fact the London Clay in the area considered is never far distant from the outcrop of the chalk, so there should be the less difficulty in effecting this all-important improvement.

After lime the most striking deficiency in these soils is in phosphoric acid; in none of the cases we have examined is there sufficient of this constituent for the proper development of even a cereal crop. The land is naturally cold and late, and the retardation of maturity is further increased by the absence of phosphoric acid.

As a rule the soil is too deficient in lime to be wholly suitable for superphosphate; this is eminently the soil for basic slag, which, however, should be applied early because of the dry climate that prevails.

Potash will generally be present in sufficient quantity if lime has been applied, mangolds being perhaps the only crop requiring an extra dressing of potash manure; sulphate of potash is better than kainit, as the soil naturally contains much magnesia. Sulphate of ammonia reduces the carbonate of lime which is often deficient, and as nitrate of soda is apt to injure the tilth of these soils a mixture of two should be used when an active nitrogenous fertiliser is required; salt is also undesirable, except for mangolds.

Typical Manures for London Clay Soils:—

For mangolds—

20 loads farmyard manure.
4 cwt. basic slag } with the dung.
1 cwt. sulphate of potash } with the dung.
1 cwt. nitrate of soda } top dressing.
1 cwt. sulphate of ammonia } top dressing.
1 cwt. salt } top dressing.

For Swedes, &c., without dung—

5 cwt. basic slag in the winter.
1 cwt. fish guano with the seed.
or 1 cwt. nitrate of soda when the plant is up.

For Meadow Land—

3 cwt. basic slag.
1 cwt. nitrate of soda.

Pastures should be occasionally dressed with 5 cwt. or so of basic slag.

On the heavier London Clay soils every effort should be made to lighten the staple; road scrapings, town rubbish, and ashes, are all valuable in opening up the soil, and should be accumulated and carted out whenever the horses can be spared. The old process of paring and burning cannot be recommended, because it creates too great a waste of nitrogen, but whenever rubbish is being burnt the opportunity should be taken to char some clay and so obtain useful material for lightening the surface soil.

Grass Mixtures for the London Clay:—

One year's ley—

	lb. per acre.
Red Clover	18
Italian Rye-grass	4
	22 lb.

For 2 or 3 years' ley—

	lb. per acre
Alsike	3¼
Red Clover	2½
Italian Rye-grass	7
Perennial Rye-grass	4
Timothy	2
	19 lb.

For 4 to 6 years' ley on Gault or London Clay—

	lb. per acre.
Alsike	3¼
Red Clover	2
White Clover	2
Perennial Rye-grass	4½
Timothy	2½
Cocksfoot	2½
Meadow Fescue	2½
Meadow Foxtail	2½
Rough-stalked Meadow-grass	¾
Crested Dogstail	½
	½
	21 lb.

For perennial pasture on Gault or London Clay—

	lb. per acre.
Alsike	3
Red Clover	2¼
White Clover	2
Perennial Rye-grass	2½
Timothy	3¼
Cocksfoot	3½
Meadow Fescue	5½
Meadow Foxtail	2½
Smooth-stalked Meadow-grass	1¼
Rough-stalked Meadow-grass	1½
Crested Dogstail	1¼
	28½ lb.

6. The Thanet Beds (Lower Eocene).

Distribution of the Thanet Sands.—Immediately below the London Clay comes a sharply contrasted formation, the Lower Eocene or Thanet Beds, a series of strata ranging from light loams to pebble beds, which only possess an appreciable outcrop in Kent, for in Surrey they are too thin to be of any importance, and in Sussex they are completely obscured by the Brick Earth of the maritime district. In Kent, however, the Thanet Sands form a series of patches on the lower slopes of the Chalk between Sandwich and Canterbury; from thence they give rise to a belt

lying between the Watling Street and the sea nearly up to London, south of which they widen out considerably. In Thanet itself but a small patch exists, but the formation is well developed and shows a good cliff section between Herne Bay and Reculver. Geologically speaking the Lower Eocene formation is subdivided into three strata, and though these have much in common there are differences of sufficient magnitude in the soils to which they give rise to justify their consideration in a little more detail.

At the top of the series comes a band of coarse sand intermixed with completely rounded black pebbles of waterworn flint, an extremely characteristic constituent of the soils derived from the Lower Eocene. In East Kent these "Oldhaven" pebble beds are only thin, but they form caps of light soil on the Lower Eocene outliers between Ash and Canterbury, in the neighbourhood of Selling and Boughton, and to a certain extent all along the main outcrop of the formation. West of the valley of the Cray, however, these pebble beds assume more importance, and their outcrop is seen in numerous commons, such as those of Blackheath, Hayes, Wickham, and Lessness Heath, and also in much of what was until recently open country near Shirley, Chislehurst, Bromley, and elsewhere. When the formations re-appear in Surrey from beneath the superficial drifts of the Thames and its tributaries, the Oldhaven Beds have thinned out and can no longer be distinguished in the small layer of sand and flints which now represents the whole of the Lower Eocene. Below the Oldhaven Beds comes another series of sands with some admixture of clay and an occasional drift of pebbles, known as the Woolwich and Reading beds, which are but slightly developed in East Kent, but assume more importance immediately to the south-east of London. The soils which these Woolwich beds give rise to are indistinguishable from those derived from the Thanet Sands below. The Thanet Sands proper, which form the lowest bed of this series and rest directly upon the chalk, are chiefly developed in East Kent, where they form beds of very fine loamy sand with a slightly greenish look when unweathered. There are several large patches between Ash and Canterbury, but the most extensive development of this formation is the strip between Faversham and Rainham, the Swale being the boundary on one side and, roughly, the Dover Road on the other. Further north this formation becomes thinner and cannot be traced separately in Surrey. It should be noticed that the continuity of these Thanet Sand areas is much interrupted by later superficial deposits of Brick Earth and alluvium.

For agricultural purposes we may distinguish two kinds of soils derived from these Lower Eocene formation: near the bottom of the series, particularly in East Kent, comes a fine loamy sand, easy to work, grateful for manure, generally amply supplied with subsoil water and resisting drought well. On the top of these loamy beds come a much coarser and lighter sand layer, often full of the black pebbles already mentioned, and this type of soil is more extensively developed in North Kent and up to the boundaries of London.

Agriculture on the Thanet Beds.—Though the Lower Eocene Beds are not extensive they are of great importance agriculturally, and on them lies much of the best farming of North and East Kent. An examination of the crop maps for fruit, hops, potatoes, and lucerne will show how thickly each of these most valuable crops is located on the Thanet Beds, and all throughout East Kent "black pebble land" is highly prized for all purposes. Practically the whole of this land is under the plough: with the low rainfall prevailing it is a little too light to carry good permanent grass, and is highly valued for more intensive forms of culture. In East Kent the lower more loamy soils carry a good many hops, but though one of the most valuable characteristics of these soils is their resistance to drought, the Thanet Sands are a little too light to form ideal hop land. Fruit of all kinds is very general—cherry orchards, apples, plums, and gooseberries in mixed plantations on the stronger soils, and raspberries, currants, and strawberries on the lighter sands belonging to the Oldhaven Beds. As a rule these fruit plantations are cultivated, grass orchards being rare. Potatoes are extensively grown within 30 miles or so of London, but not much in East Kent. Barley of malting quality is also regularly grown. Fig. 30 shows a typical view on the highly cultivated Thanet Sands in East Kent.

In the farming on the Thanet Beds no regular rotation is followed: the soil is light and readily worked, the land dries early in the spring and matures rapidly in the autumn, and the farmers are so much concerned with market gardening, that they crop their land irregularly and get in something or other as fast as they can clear the ground. This is particularly the case nearer to London, where much of the land is held by small men who keep no stock, but sell everything off the land and depend on London dung to maintain soil fertility. Cabbage and other green vegetables, peas, potatoes, carrots, and parsnips, form the staple crops, but they are alternated with mangolds and other fodder crops to sell to the neighbouring cow-keepers, and with occasional crops of corn, the latter having been on the increase of late.

In East Kent the land is under more regular farming, and there fine crops of wheat, barley, and roots are grown. Light as the land is it poaches rather badly under sheep and should not be folded late in the season. Indeed the land is not well suited to folding, because the succeeding corn crop tends to go down. The Thanet Sands cannot be worked, as in the case of purely sandy soils, without any care as to whether they are wet or dry; if they are ploughed too soon after rain they dry with a hard steely surface and cannot readily be brought again into a fine tilth. Again, if a good tilth has been obtained for a seed bed and rain follows immediately, the surface is apt to run together and dry with a hard glazed "pan" on the top, which may easily prevent the seed from coming through. Under proper management, however, these sands are cheap to work and are distinguished by the manner in which they will carry their crops through the hot dry seasons which prevail in

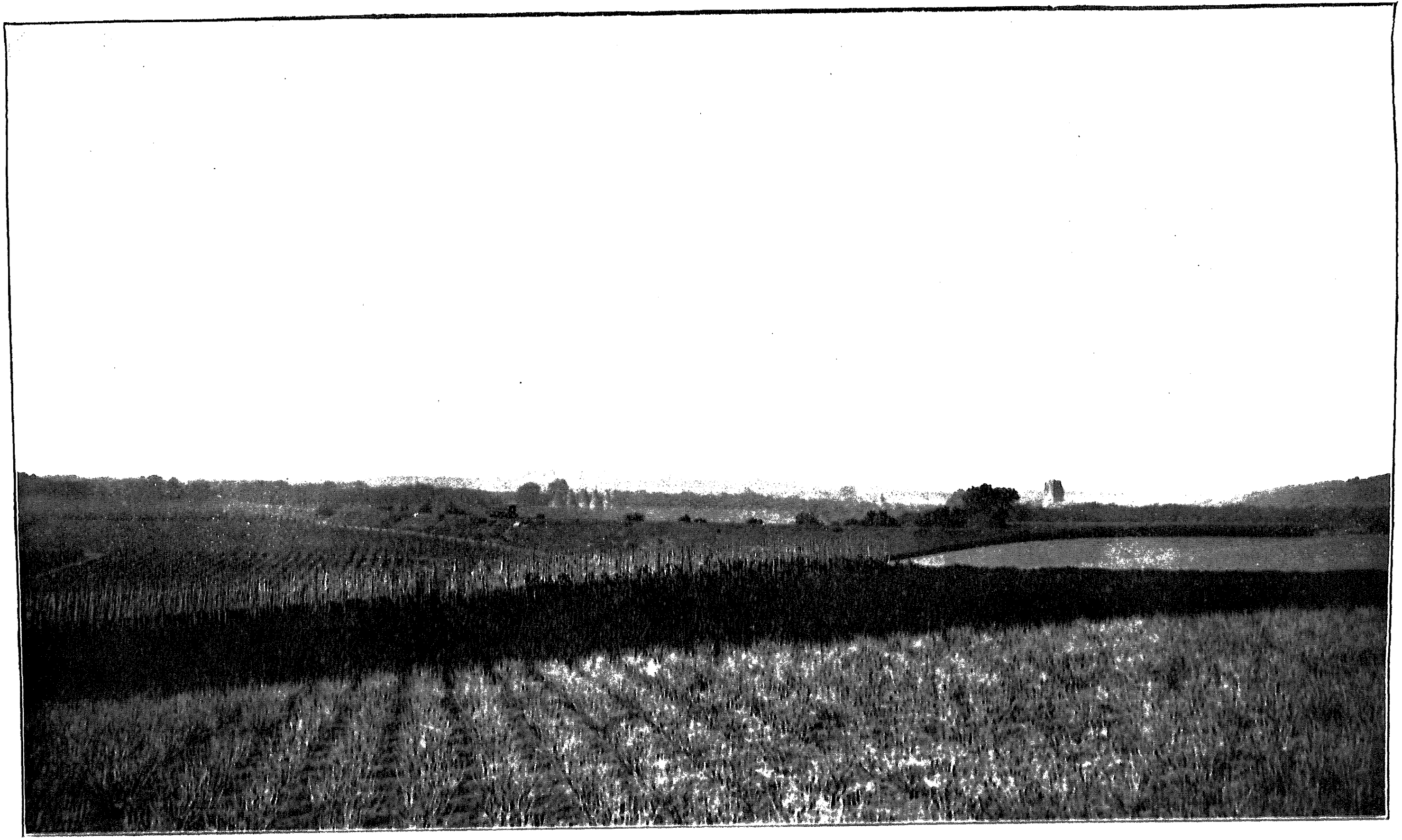


Fig. 30. Highly Cultivated Thanet Sands, Newington, Sittingbourne.

(*To face p. 95.*)

East Kent; indeed, the farmers on these soils prefer dry to wet summers. The lower beds of the formation naturally carry a good deal of subsoil water, which has drained through the light coarse sand of the upper strata and is held up by the loamy beds and thin partings of clay near the base of the series. Furthermore, owing to the preponderance of fine sand and silt the texture of the soil is such that it is able to lift water readily from the subsoil towards the surface in order to replace losses by evaporation; the soil particles possess a large surface and yet there is not an excess of clay to hold the water too tightly and delay its movements in the soil. As will be seen later, it is the fine but not the very fine grades of particles which predominate in this soil.

Being light the soils on the Thanet Beds are weedy: the most troublesome weeds on these soils are Knotweed or Wiregrass (*Polygonum aviculare*, L.), Black Bindweed (*P. Convolvulus*, L.), Field Nightshade (*Solanum nigrum*, L.), Fat Hen (*Chenopodium album*, L.), Bindweed or Bearbine (*Convolvulus arvensis*, L.), which is very troublesome in the fruit plantations, Horsetail (*Equisetum arvense*, L.), Mayweed (*Anthemis cotula*), Mugwort (*Artemisia vulgaris*, L.), Speedwell (*Veronica agrestis*, L.), and Poppies (*Papaver* sp.), among the corn, with the Annual Stinging Nettle (*Urtica urens*, L.), Thistles (*Carduus* sp.), and Docks (*Rumex* sp.). Couch grass (*Triticum repens*, L.) is common, but Charlock (*Sinapis arvensis*, L.) does not occur commonly on this formation. Spurrey (*Spergula arvensis*, L.) and Sheep's Sorrel (*Rumex Acetosella*, L.) also occur when the land has been allowed to become sour.

Very little woodland is seen on this formation, but where the banks are too steep and dry for cultivation copses of Spanish Chestnut for hop poles are common, and in the wet bottoms similar copses of ash are sometimes planted.

On the pebbly Oldhaven beds in the neighbourhood of London a number of commons and wastes exist—Bromley, Hayes, Keston, and Dartford Heath—because the land has never been worth bringing into cultivation. They carry the usual vegetation of dry sandy soils, though they do not show so many distinctively peat-loving acid-soil plants as do the Bagshot Beds in Surrey: still, such lime-hating plants as Gorse (*Ulex* sp.), Heather (*Calluna vulgaris*, Salis.), and the two Heaths (*Erica* sp.) and (*Digitalis purpurea*, L.), Foxgloves, and the Sundew (*Drosera rotundifolia*) are to be found, together with Spanish Chestnut and Birches in the plantations.

Composition of the Thanet Sands.—The mechanical analyses of the soils from the Lower Eocene Beds show considerable diversities of composition, which are indeed to be expected from the double change in the character of the formation, lighter towards the top and again in passing from East Kent to North Kent.

The lightest soil in the series is one taken from the uncultivated surface of Hayes Common; even in the surface soil the pebbles weighed more than the fine soil, while the subsoil was too stony to permit of sampling. This soil, No. 76, contained

nearly 7 per cent of fine gravel and 13 per cent of coarse sand, though the fine sand forms the largest fraction, 36 per cent, and the clay is only a little over 3 per cent. Such a soil, so full of coarse material and with so little clay, can have only the smallest water-holding capacity, and very little power of retaining manure.

Soil No. 77, a cultivated soil from West Wickham, though situated near the last soil and equally belonging to the Oldhaven Beds, as judged from its position and the presence of black pebbles, is distinctly heavier, for it contains over 7 per cent of clay and almost as much fine silt. Another Oldhaven soil from the other end of the outcrop in East Kent, No. 80, from Woodnesborough, is still less light, for though the clay is about the same, there is but little coarse sand, the fine sand being much the largest fraction. This soil is regarded by its occupier as better suited to strawberries and vegetables than to ordinary crops. Yet, though the Woodnesborough soil is of undoubted Oldhaven origin it is not so light as others which are derived from the Thanet Beds; for example, the two soils, Nos. 181 and 193, taken one from near Swanley, the other from the neighbourhood of Newington, while resembling one another very closely, are both lighter than the Woodnesborough soil, since they contain much more coarse sand and distinctly less clay. In addition to the two soils just quoted there are a number derived from the Thanet Beds which contain a considerable proportion, up to 16 per cent of coarse sand, while the clay lies between 9 and 11 per cent. Side by side with these, often at a very short distance, because the Thanet Sand areas have often been eroded into rather steep slopes, comes a heavier type of soil with little or no coarse sand and 10 to 15 per cent of clay. It is these latter soils which are found on the most fertile land, and it will be seen that they approximate very closely in type to the Brick Earth already described; indeed, from the mechanical analysis alone it would be impossible to settle to which group an unknown soil should belong. Occasionally even heavier patches of soil are found, as for example soil No. 117a from Newington, which is described as constituting an unproductive patch in a good orchard, from the better portion of which soil No. 117b was taken. It will be seen that the soil and subsoil of the bad part contain about 5 per cent more clay than the corresponding soil and subsoil of the good part. Perhaps the most distinctive character of the valuable soils on the Thanet Beds is their richness in the "silt" fraction, which in some cases constitutes 40 per cent of the whole soil. This is essentially material which is coarse enough to permit of the rapid downward percolation of water, but which yet possesses a large enough surface to lift the water back from the subsoil in time of drought. It is the important position assumed by this fraction, and the general well-balanced distribution of the various grades, which confer on these Lower Eocene soils their value under the plough.

From the chemical standpoint the Thanet Sand soils occupy a position between the Bagshot Beds and the Brick Earths. They contain distinctly more carbonate of lime than do the Bagshot

Beds, but whether this is due to the calcareous fossil shells so common in certain layers of the Thanet Beds or to artificial chalking, is hard to decide; though in some cases it is probably the latter, since the subsoil contains less than the soil. Moreover the water in the Thanet Sands is distinctly calcareous, and this tends to preserve the neutrality of the soils. It is only on some of the heath land in North Kent that signs of real acidity in the soil are common. "Finger-and-toe," however, is common everywhere on the formation, while sheep's sorrel and spurrey are often found as weeds, so that the neutral borderline is often being crossed and all the land is without doubt the better for an occasional good chalking. The amount of nitrogen is variable, being about 0·13 per cent in the lighter soils and rising to 0·25 in the loams; soil No. 76 from Hayes Common is an exception for it contains the highest percentage of all (0·43), but this represents the accumulation of peaty vegetable matter in a sour heath soil. The potash is somewhat higher than would be expected from the light character of the soils, varying from 0·3 to 0·5 per cent, though in two cases (Nos. 181 and 193); both highly cultivated soils, it is lower, only 0·22 and 0·20 per cent. The available potash is low, 0·01 to 0·02 per cent. and experience has shown that these soils generally respond to potash manuring. The magnesia ranges from 0·2 to 0·7 per cent, and is generally less than the lime. The amount of alumina is as usual about one-third that of the clay: the oxides of iron are low, from 2 to 3 per cent, and ferrous compounds are not found. Only traces of manganese could be detected. The phosphoric acid is generally below 0·1 per cent. with less in the subsoil: only in the heavily manured hop garden soils is more to be found. The available phosphoric acid is, however, very high, ranging from 20 per cent up to as much as 50 per cent of the total. The sulphuric acid is comparatively high, ranging from 0·05 to 0·08 per cent.

Manuring of the Thanet Sands.—In the list of manures employed on the Thanet Beds, dung occupies the most prominent position; the market gardeners use little else and even in East Kent large quantities are brought by barge, partly from London and partly from the cattle boats unloading at Deptford. Dung alone, however, is not the best manure for these soils, which are already poor in mineral matter; phosphatic manures answer very well, superphosphate and bone meal being the best according to local experience, while for crops like clover and mangolds some potash salts are indispensable.

The following mixtures would serve for the lighter type of soils:—

Swedes without dung—

The land should be chalked or get 10 cwt. per acre of ground lime on the stubbles the winter before the swedes are taken. In addition, 5 to 6 cwt. per acre of a mixture made with 3 parts of superphosphate to 1 part of bone meal and 1 of fish guano, well mixed into a tight heap on the floor of a barn, left 2 or 3 days and then broken down before drilling with the seed, will be useful. This may be followed by half a hundred weight per acre of a

mixture of equal weights of sulphate of ammonia and nitrate of soda used as a top-dressing at singling time. This mixture should be mixed with ashes or earth, otherwise it is almost impossible to sow ½ cwt. per acre evenly.

Potatoes—

12 to 15 tons of dung per acre in drills; sprinkle on this 3 cwt. per acre of phosphatic guano or the phosphatic mixture described for swedes, and about 1 cwt. per acre of sulphate of potash. Top-dress with 1 cwt. per acre of nitrate of soda when the haulm is growing vigorously. Avoid lime.

Cabbages, &c.—

10 to 15 tons of dung per acre; 5 cwt. per acre of the phosphatic mixture described for swedes, followed by 1 to 3 cwt. per acre of nitrate of soda.

Mangolds—

10 to 15 tons of dung per acre; 5 cwt. of kainit per acre sown broadcast in the winter; 2 cwt. of the phosphatic mixture drilled with the seed; 1 to 2 cwt. of nitrate of soda as a top-dressing.

Seeds—

Whenever clover, lucerne, or sainfoin is to be taken, about 4 cwt. per acre of basic slag should be worked into the soil before the cereal crop in which the small seeds are going to be sown. Then 4 cwt. per acre of kainit should be sown on the young seeds in the first winter.

On the light soils it is of great importance to sow every crop as early as possible; the manures also should be got on in good time, but in the case of active manures like guano, fish and meat meal, rape cake, superphosphate and potash manures, they should reach the land but a short time before the crop is sown: only the more loamy land can be counted on to retain the fertilisers long for the crop.

"Seeds" mixtures, except for temporary leys (red clover alternately with a mixture of sainfoin, trefoil, and rye-grass, answers well), are not much wanted on the Thanet Beds, but the prescription given for the Bagshot Beds will answer on the light soils, that for the Brick Earths will serve on the better loamy soils.

7. The Chalk Formation.

Distribution of the Chalk Formation.—The Chalk forms one of the most distinct divisions of the land of England; wherever it occurs its aspect, either as regards the physical appearance of the country, the characteristic vegetation—trees, shrubs, and flowering plants—or the methods of farming practised thereon, is quite unlike that of any other soil. In each of the counties with which we are concerned the Chalk figures largely; it has already been stated that it is divided into two masses, the South Downs, which are confined to Sussex alone, and the North Downs, which run through the whole length of Surrey and Kent. Both take their origin in the central mass of Chalk in Hampshire,

Butser Hill, the actual meeting place of the two ridges, being a few miles outside the area considered. The North Downs enter Surrey at Farnham as a very narrow ridge, the top of which is about 450 feet above sea level, dropping steeply on the south side to the Gault valley, and almost as steeply to the north to the wider valley formed by the London Clay; so sharply pitched indeed is the ridge that the whole outcrop of the Chalk is not more than 800 yards wide between Farnham and Guildford. The narrow outcrop and steep face is the result of the very high angle at which the strata are dipping: they make an angle of about 40° with the horizontal at this end of the great earth fold which has been the origin of the Weald. The Hog's Back, as the narrow ridge is termed, continues in this fashion as far as Guildford, where comes one of the great gaps cut by a Wealden river (the Wey) making its way northward into the Thames. East of the Wey the dip of the strata becomes less and the outcrop broadens, becoming about five miles at the point where the next river gap is formed by the Mole between Dorking and Leatherhead. This part of the chalk ridge shows all the features which characterise the range of North Downs as far as Dover; beginning from the south there is a narrow terrace of white Chalk Marl in the valley, then comes the steep face of the escarpment, which while preserving a general east and west line, is hollowed on the face into deep circular-ended valleys called coombes. The highest part of the ridge, here about 700 feet above sea level, comes just at the crest of the escarpment and the surface on the top of the plateau is generally covered by the Clay-with-Flints and occupied by woodland. Going northward still, the land begins to fall and the superficial deposit of Clay-with-Flints thins out until it ceases to be distinguishable, whereupon the special features of the Downs appear in the open sheep walks or rolling arable fields without trees or hedges. East of the Mole the chalk area still widens, until from Reigate to Carshalton it attains a breadth of about ten miles and runs up to a height of nearly 700 feet. At this point occur two more gaps in the Chalk, through one of which the Brighton road and railway runs, while the second is occupied by another old road and the Caterham Valley branch of the South Eastern Railway; both these valleys, however, are dry, and at their highest points are well over 400 feet above sea level.

Beyond the Caterham Valley the Chalk becomes still higher: between Woldingham and Oxted the escarpment reaches the height of 868 feet and the ridge continues at about the same breadth and nearly the same height until at Otford it is once more cut through by a river—the Darenth. For the next eight to ten miles the outcrop is somewhat narrower and the height not quite so great until the Medway is reached, a somewhat broader valley than any of the previous gaps. Beyond the Medway valley there is a continuous stretch of Chalk for more than twenty miles to the Stour valley, the escarpment on this section rarely exceeding 650 feet in height; on the North Downs here—indeed all the way from the Darenth Valley eastwards—there is very little open sheep walk, because the lower slopes of the Chalk

are mostly covered by the highly cultivated Thanet Sands and Brick Earths. East of the Stour the Chalk widens out once more, forming an area some 16 miles long from Canterbury to Dover and about the same breadth from the escarpment to the sea. This last area may be subdivided by a line drawn roughly along the Watling Street from Canterbury to Dover: south and west of this line the Chalk, which just reaches 600 feet in two places, is covered by Clay-with-Flints and is largely in woodland, while to the east it rarely reaches the 400 feet contour and is free from superficial deposits, in consequence of which it is occupied in the main by unenclosed sheepwalks and arable fields. Finally, in East Kent there is a detached chalk area, the Isle of Thanet, due to the second fold in the strata which brings the Chalk to the surface again, and this also forms bare open land, though almost entirely under the plough, a typical view of which is shown in Fig. 29. The open land mainly lies upon the upper White Chalk with flints; the escarpment is formed by the Middle Grey Chalk without flints; and it is upon the reverse slope of this latter formation that the Clay-with-Flints rests. In Figs. 31, 32 and 33 may be seen the typical steep face of the escarpment with the cultivated terrace of Chalk Marl below.

When the South Downs enter Sussex on its western boundary above Harting they form a ridge about six miles broad, rising steeply from the Upper Greensand terrace on the north, which is about 200 feet above sea level, to something over 700 feet (818 feet at Linch Down). So steep is the slope that some fields do not see the sun for four months in the year. The back of the slope, *i.e.*, to the southward, is deeply cut into coombes and valleys, in which two small rivers (the Ems and the Havant) take their rise, and the former extension of this latter stream has given rise to the dry valley or col between Cocking and Singleton, through which at a height of a little more than 300 feet run both rail and road to Chichester. This section of the South Downs extends eastward for about twenty miles with no other break until it is cut through by the valley of the Arun between Amberley and Arundel. It differs markedly from all the rest of the South Downs in being heavily wooded along its whole length, carrying some magnificent beech plantations; probably the height of this region and its comparatively heavy rainfall account for the persistence of the woodland, which at one time was continuous with the Forest of Bere to the south-west. East of the Arun there is a stretch of Downs, now open sheepwalk in their highest portions and arable land in the valleys and on the lower slopes, for about ten miles, as far as the valley of the Adur. The escarpment is usually under 700 feet high, though at one point, Chanctonbury Ring, 814 feet is reached; again the ridge is traversed by a col, along which the road to Worthing passes. East of the Adur the Downs, which behind Brighton are still about six miles wide, come right down to the sea, the maritime plain having thinned out and disappeared; the escarpment is well over 700 feet high and at Ditchling Beacon reaches the highest point in the county, 858 feet.

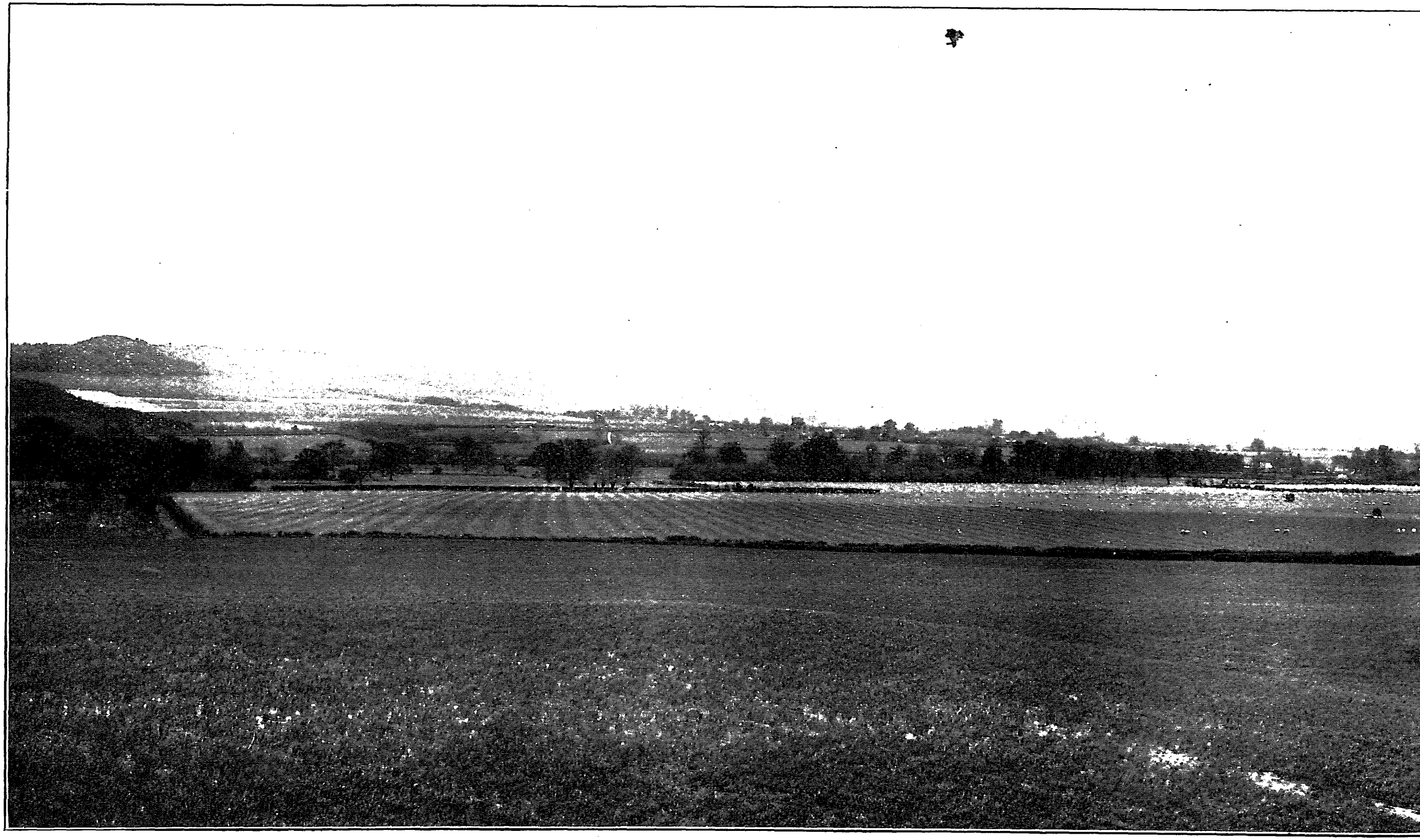


Fig. 31.—The Chalk Escarpment looking S.E. from Boughton Lees.

(*To face p. 96.*)

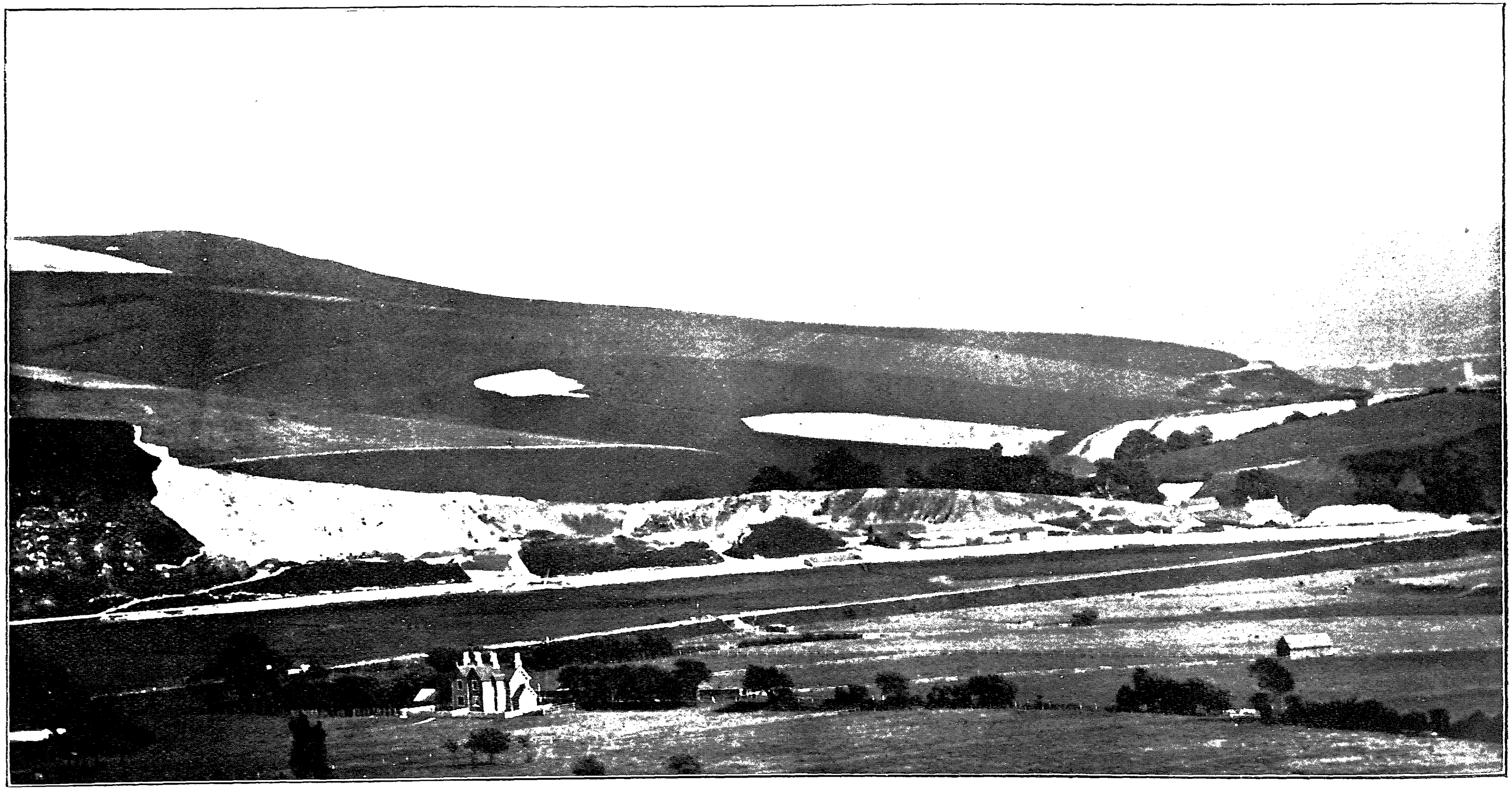


Fig. 33.—Gap in the Downs made by the Glynde Reach near Lewes.

(To face p. 96.

Fig. 32.—The Chalk Escarpment near Kit's Coty House.

(To face p. 96.)

The escarpment is penetrated by one col at Pyecombe, and is also turned by the lateral valley from the Ouse, along which run the rail and road from Lewes to Brighton. Along this line Brighton is reached without crossing any point higher than Falmer, 272 feet above sea level. In this section the Downs are bare and open, as they are again on the other side of the valley formed by the Ouse, east of which there are still 15 miles of Down until the sea is reached at Beachy Head. [illegible] lie in the hollows so as to be sheltered from the wind; here also the only trees in this region are to be found. In Fig. [illegible] a typical view of this treeless down country is given. At Lewes the Ouse cuts a very striking and well defined gap through the Chalk mass, the hills rising steeply on either side of the town to over five hundred feet. A second gap, shown in Fig. [illegible], is also formed by the Glynde tributary of the Ouse, thus cutting off Mount Caburn as an apparently isolated patch of down. The [illegible] stretch of Downs is not so high, though Firle Beacon [illegible] to 718 feet and Beachy Head itself is nearly [illegible] feet [illegible]. It is also traversed by one of the narrowest of all the gaps through the chalk, that formed by the Cuckmere River, which rises [illegible] Heathfield on the southern side of the same Weald [illegible] give rise to the Rother. However, it flows across the Weald [illegible] plain at a height of less than 50 feet above sea level [illegible] a mile or so of the streams running into Pevensey Level, but then in order to reach the sea, it breaks through the Chalk [illegible] sides of its valley rising to 600 feet. More perhaps [illegible] other place it is here evident that the courses of the Wealden rivers must have been laid down before the present [illegible] of the county had been established (see p. 4).

The open South Downs are generally covered by a layer of red flinty soil, which is very thin on the higher ground and is there very often black in colour, but may be two feet thick or more in the bottoms of the coombes. This thin soil has been very thoroughly decalcified and responds to manures containing lime, such as basic slag. In other places on the slopes the usual whitish chalk soil prevails. In this area the farms are large and well managed: Cobbett speaks of them as "some of the finest farms in the world," and Young writes "the whole tract of the Downs is stocked with sheep, and the amazing number they keep is one of the most singular and curious circumstances in the husbandry of England." The sixty miles between [illegible] and Steyning was stocked at the rate of 1½ sheep per acre, which "is, the soil considered, the highest stocking that is known in this kingdom."

The most striking feature of the chalk areas is their waterless appearance. Excepting for the rivers rising in the Weald and cutting across the Chalk there are very few streams [illegible] the formation: the Wandle and the Cray have their [illegible] on the Chalk: the Little Stour rises on Chalk, though [illegible] it continues over the Thanet Sands: and the Dover stream is all on the Chalk: otherwise the whole area of the North Downs is without running water. The South Downs in their turn can only

claim the Ems and the Lavant as rising and flowing over the Chalk, though in some of the coombes springs occur at the foot of the escarpment, and a few more rise on the other side of the hills where the land runs down into the marshes, but none of these flow over the Chalk for many yards. The porous nature of the chalk rock, and its solubility in rain water that has taken up carbonic acid from the layer of vegetable soil, result in the formation of dry valleys, the bottoms of which are laden with the flint stones representing the chalk that has been removed in solution, while the drainage is going on in the chalk rock itself below the surface. The smooth rolling curves of the true chalk country are the outcome of this removal of the rock by solution—a slow etching out of the landscape with none of the sharp cutting effects due to a running stream.

Owing to the porous nature of the Chalk and the elevation of the Downs, the water table (*i.e.*, the level of permanent saturation at which water stands in the wells) is often at a great distance from the surface; near the escarpment wells are usually over 200 feet deep, and the labour of obtaining water adds to the difficulty of farming at these heights. A certain amount of water is obtained from dew-ponds, which are more common upon the South than upon the North Downs. The mode in which dew-ponds collect and store water is still in dispute, but as far as the evidence goes they are generally set a little back from the edge of the escarpment and at the summit of the col which one of the valleys has cut back to the escarpment, so that they are often in a position to receive a certain amount of surface drainage when the rainfall is heavy. The dewpond has always a puddled clay bottom to prevent loss by percolation and occasionally there are trees or thorn bushes overhanging it on the seaward side, which help to feed the pond by the very heavy drip from the branches that occurs during the frequent sea fogs coming up from the Channel. Very few meteorological data exist for these summits, but at least it is known that they possess a higher rainfall and a lower mean temperature than the lower ground; also they are much subject to sea fogs in the driest weather, so that the greater precipitation and the lessened evaporation may account for the permanence of water in these dew-ponds.

In the valleys inside the mass of Chalk springs will begin to break out wherever the valley is cut down to the permanent water table, and as this level fluctuates with the seasons such chalk springs are often intermittent and are known as "Winterbournes" or "Nailbournes." The source of the Little Stour in East Kent affords a good example; in ordinary seasons the stream begins to flow at Well Chapel near Bekesbourne, above which a dry valley extends for eleven or twelve miles as far as Etching Hill. After long-continued wet weather, as after the rainy summer of 1903, and the autumn of 1909, the spring breaks out at Etching Hill, and runs down the previously dry valley in fair volume for some months; it then suddenly ceases to flow from the upper source and only runs from the lower one. That a winterbourne does not creep up and down a valley with the season, but only flows from two definite points, appears to be due to a bed

of clay or loam which covers the floor of the valley between the two points: although the level of the water table is usually above the lower source the water emerges at that point only because the clay or loam in the bed above is impervious enough to keep the water from coming to the surface. In wet seasons the water table rises in the Chalk until it comes above the higher winter-bourne source, which represents some break in the impervious bed of loam; as soon as the water level rises above this point the stream breaks out and perhaps runs over several miles of the valley that was previously waterless and will be left dry again as soon as the water level again drops below the upper spring.

From what has already been said it will be evident that the true chalk soils do not occupy very extensive areas on the North Downs near the escarpment, but on the face of the escarpment, and on the sides of the valleys where the slope has been steep enough for the Clay-with-Flints to wash away, the rock is near the surface and the soil is a highly calcareous one of the type recognised as a chalk soil. Back from the escarpment on the surface of the Upper White Chalk, especially in East Kent and Thanet, the Clay-with-Flints has disappeared and true chalk soils prevail, as they do practically all over the area of the South Downs.

Agriculture on the Chalk Formation.—The true chalk soils are easily recognisable by their very characteristic vegetation, the most varied and the richest in flowering plants and shrubs of any in this country. The beech, yew, and wild cherry are the most typical trees, beech groves crowning many of the heights on the South Downs, while long lines of yew mark such old roads as the Pilgrim's Way (really an early British trackway along the line of the North Downs, and in one or two places great groves of yew exist, like the famous one on the line of the old "Stone Street" south of Leatherhead, and in Kingley Bottom near Singleton.

The hedgerows are particularly interesting on the chalk: they are full of flowering shrubs, the Beam Tree (*Pyrus Aria*, Ehrh.), the Mealy Guelder Rose (*Viburnum Lantana*, L.), the Dogwood (*Cornus sanguinea*, L.), the Sweet Briar (*Rosa rubiginosa*, L.), being universal, and always intertwined and enlaced by the Traveller's Joy (*Clematis vitalba*, L.), the surest of all signs of a calcareous soil. On the rough banks the Juniper is common, though it is not seen on the South Downs east of the Adur, and in some places, Boxhill in Surrey and below Chanctonbury in Sussex, though more frequently in the past, e.g., Boxley in Kent, the Box grows wild.

The lower vegetation is wonderfully rich in flowering plants; the rarer members of the Orchid family are only found on the Chalk, as are several other plants of too great rarity to be [illegible] a feature in the landscape, but the open downs are always yellow with the blooms of the Rock Rose (*Helianthemum vulgare*, Gært.) and the Horse-shoe Vetch (*Hippocrepis comosa*, L.). Other leguminous plants, particularly the Kidney Vetch (*Anthyllis Vulneraria*, L.) and Bird's Foot Trefoil (*Lotus corniculatus*, L.) are everywhere abundant, but are not so exclusively

confined to the Chalk. The Dropwort (*Spirea Filipendula,* L.), Salad Burnet (*Poterium sanguisorba,* L.), Milkwort (*Polygala vulgaris*), certain Gentians like *Gentian Amarella,* L., and *Chlora perfoliata,* L., and particularly a number of aromatic labiates like Marjoram (*Origanum vulgare*) and Thyme (*Thymus serpyllum*), are to be found in all the short grassy sheep walks; while the waste places and the roadsides show Chicory (*Cichorium Intybus,* L.), Wild Parsnip (*Pastinaca sativa,* L.), Viper's Bugloss (*Echium vulgare,* L.), and Bladder Campion (*Silene Cucubalus,* Wibel.). Among the characteristic grasses are the Downy Oat (*Avena pubescens,* Huds.), the Upright Brome (*Bromus erectus,* Huds.), the drought resisting Sheep's Fescue (*Festuca ovina,* L.), and Sweet Vernal (*Anthoxanthum odoratum,* L.); the Yellow Oat (*Avena flavescens,* L.) contributes much of the early spring growth, while great breadths of the higher grass land are ruined by the prevalence of the "Tor" grass (*Brachypodium pinnatum,* Beauv.), a harsh tufted species refused by stock. As on all light land, the uneaten culms of the Crested Dogstail (*Cynosurus cristatus,* L.) are prominent during the late summer and winter. The Down pastures carry only a small number of sheep and are quite without capacity for fattening stock, but they are extremely healthy and free from any suspicion of harbouring parasitic disease.

The South Down sheep require hay in the winter, but as the permanent grass is unsuitable for mowing, hay is provided by the "seeds" crop grown in the rotation. Chalk land farming is all founded upon sheep; the grass is not good enough nor is there sufficient water for horned stock, while there is no cheaper way of both growing meat and enriching the land than folding sheep upon the fallow crops, particularly as the sheep also do much towards the consolidation of the land which is always so necessary upon the chalk. In the South Downs we see the typical sheep country; open grassy Downs on the heights for the store stock and the ewes, with the homesteads in the great hollows of the hills surrounded by wide expanses of open fields, over which the fold moves at least once in the rotation, often indeed every other year. These farms all live by their sheep, and the aim is to keep as many as possible. If the land is overstocked heavy losses are incurred at lambing time, and there is an old saying that the sheep will die down to the proper number. Even where dairy stock are being introduced the number of sheep is kept up as far as possible, and as the grass has but little feeding value and the stocking is heavy, the first consideration in the farming is to obtain a succession of folding crops. For this purpose swedes are but little grown, since they are considered to have less feeding value on the Downs than on the Greensand; rape and thousand-head kale take their place, and wheat, sometimes spring sown, generally follows the fallow on the eastern part of the area, and oats in the western, barley being but little grown. In the western district part of the fallow area is sown with vetches and rye or winter barley for spring folding. In the corn crop "seeds" are sown, a mixture of Italian ryegrass, trefoil, and Dutch clover being common, especially where

the seeds are grazed. Red clover is also grown for hay. The "seeds" are followed by wheat or oats, and a catch crop is often sown on the stubble to be folded off before the fallow crop proper; catch cropping is, however, more common in the west with its greater rainfall. In any case the soil is sometimes very dry for the catch crop; it is necessary to plough in the seed and manage the tilth very carefully to get a plant. Thus, while no very strict rotation is adhered to, the cropping in the main follows the four course system. With the very continuous cropping the light land easily gets foul, docks, twitch, and charlock giving the most trouble. It is in this chalk country that oxen are still used to plough, though they are disappearing because they are too slow to work the reapers and binders. As a rule the flocks travel from the downs to the fold and back every day, but sometimes the plan is practised of keeping the fattening sheep on the arable land until they are fat. Sometimes as many as 2½ or 3 sheep to the wattle are folded. The main practice, however, is to sell off the lambs and the cull ewes in the early autumn to be fattened on the turnips grown on the Greensand farms.

In East Kent, though sheep are still the basis of the farming, rather more crops for sale are grown, and, as has been explained already, catch cropping is not so general owing to the smaller rainfall. Peas or beans are generally included in the rotation, of which the following may be taken as an example: roots, barley, peas, wheat, clover or sainfoin, oats or wheat followed by oats, thus making a six or seven years' course: four and five year courses are also adopted but clover and sainfoin are alternated, and it is difficult to take swedes with less than a five years' interval between two crops. The dung is generally put on for the wheat, and the root crops are grown upon the flat with artificial manures.

The great difficulty of East Kent farming upon the Chalk is to retain moisture enough in the soil, and all the cultivation operations must be directed to that end. The stubbles should always be ploughed in the autumn both to collect as much as possible of the winter rainfall and to secure a tilth, for despite their lightness these chalk soils will dry with a steely caked surface if injudiciously worked when wet. In preparing the seed bed the Kentish broadshare plays a great part; its heavy beam and flat plate keep packing the lower soil as it reduces it into a crumb, until at last the land is left in a very fine condition on the surface but tightly pressed below. The roller must be freely used both on the spring corn and young seeds, and while the root crops are germinating; indeed an old East Kent custom is to "cart wheel" the roots by drawing a laden cart up and down the field so that the wheel tracks come close to the drills. The grass land on Chalk has an even greater tendency to become open and "hover"; it always contains an exceptional number of worms and shows an enormous amount of wormcasts in spring and autumn, until if neglected it becomes extremely spongy under foot. The chalk grass land also becomes very mossy during the winter, not because it is wet or sour but because the

grass does not fill up to a close sole but leaves bare spaces, upon which the moss seizes. Continuous rolling has been found the best means of keeping this moss under; indeed too much stress cannot be laid upon the necessity of the roller upon all classes of chalky land, especially in the drier districts. The open nature of the chalk arable country is also very hurtful to the conservation of water in the soil; though hedges will not grow in a very satisfactory manner much might be done by belts of pines, or even by temporary lines of thatched hurdles, to break the sweep of the drying winds of spring, with immediate good results to the crop.

Parts of the chalk country in Surrey which lie on the lower slopes of the Downs from Sutton through Cheam, Ewell, Epsom and on to Guildford are very highly farmed by cow-keepers and potato farmers. These farmers use enormous quantities of London dung both for their potatoes and for the heavy mangold crops at which they aim in order to provide succulent food for the cows in winter. Again, along the northern slope of the Hog's Back there is a piece of highly farmed country where potato growing is a speciality; the steep northern slope of the hill keeps the land cool and moist, and very large yields of main-crop varieties can be grown. Potatoes are taken once in four or five years on a rotation of potatoes, wheat, seeds, oats, and the potatoes are given a heavy dressing (as much as 25 tons per acre) of London stable manure with a further addition of a complete artificial manure.

The most distinctive of chalk land crops, though in the district considered they are chiefly to be found on the North Downs, are sainfoin and lucerne, both of which flourish extremely and will give abundant fodder in the driest seasons. Sainfoin is generally sown for a one or two years' ley, though it can be left down much longer; it grows rapidly and gives a good cut for hay in its first year, with an aftermath which affords the best of grazing for lambs. Sainfoin also grows well in mixtures, and on this soil some should always be included in mixtures for permanent grass. Lucerne is sown pure because it makes rather a thin growth at first and can easily be crowded out, although a little seed should always be included in a permanent grass mixture on Chalk, so valuable is its deep-rooting habit. Lucerne and sainfoin for hay are specially characteristic of the Thanet farming; roots are less grown in that dry windswept area than in cooler districts, but lucerne and sainfoin are left down for five years to be followed by as many successive white straw crops, interspersed with peas, and vetches or mustard for sheep keep. Crops for seed are also common features in the Isle of Thanet, the agriculture of which is in many respects different from that of East Kent.

The typical home of the essential oil plants, lavender and mint, is on the thin chalky soils, where alone they develop their highest proportion of scent. Watercress is another crop special to the Chalk, it being almost confined to the tributaries of streams fed by calcareous water.

It has already been mentioned that below the Grey Chalk which forms the scarped face of the Downs there comes a stratum of Chalk Marl (Figs. 31, 32), and this forms a strip of heavy sticky white soil immediately under the Downs all round their sweep. In Kent it is difficult to be sure where this Chalk Marl terrace merges into the Gault, which itself is calcareous in its upper layers, but in Surrey and below the South Downs in Sussex, where the Upper Greensand is developed, the Chalk Marl and Greensand together form a terrace with a distinct further dip to the Gault. The Chalk Marl is almost everywhere under the plough and forms a good free working, if rather stiff soil, which grows excellent cereals and rarely dries out.

Arable soils on the Chalk are very weedy and cover themselves rapidly with a thick mat of annual weeds, among which Fumitory (*Fumaria officinalis*, L.), Creeping Buttercup (*Ranunculus repens*, L.), Corn Crowfoot or Buttercup (*R. arvensis*, L.), Henbit and Red Deadnettle (*Lamium amplexicaule*, L., *purpureum*, L.), Dove's-foot Cranesbill (*Geranium molle*, L.), Procumbent Speedwell (*Veronica agrestis*, L.), Shepherd's Purse (*Capsella Bursa-pastoris*, Mœnch.), and Poppies (*Papaver Rhœas*, L. and *P. dubium*, L.), with Charlock (*Sinapis arvensis*, L.), are the most troublesome. In gardens and fruit plantations Bearbine (*Convolvulus arvensis*, L.), is perhaps the greatest pest.

Composition of the Chalk Soils.—The mechanical analyses of the chalk soils vary more than do those of any other formation, and no common type can easily be discerned running through the whole series. In the first place they differ very much as to the amount of carbonate of lime they contain; the analyses show as little as 1·5 per cent (No. 266), and as much as 66 per cent (No. 263), this last being taken high up on the South Downs near the Devil's Dyke. Subsoil No. 7 taken in the Stour Valley is undoubtedly a Brick Earth, which has been covered by a chalky rain wash from the hills above, because the surface soil contains nearly 8 per cent of carbonate of lime. There are, however, other cases in which the surface soil contains more carbonate of lime than the subsoil, and possibly these are to be explained by the evaporation near the surface of water charged with bicarbonate of lime which had been lifted from the subsoil by capillarity, so that carbonate of lime is constantly being deposited near the surface where evaporation goes on. The Rothamsted experiments have shown that carbonate of lime never shows any tendency to sink in arable soils, though a certain amount is permanently removed from the surface soil every year; but the Rothamsted figures are not inconsistent with the idea that when a subsoil is well provided with calcium carbonate it will tend to accumulate near the surface by solution and redeposition.

Putting aside the carbonate of lime the other constituents of the soil still show great variations; the coarse sand for example is less than 2 per cent in soils from Meopham and Sutton by Dover, less than 1 per cent in the soils from the South Downs, but rises to nearly 9 per cent out of 43 per cent (57 per cent being carbonate of lime) and to 18 per cent out of 61 per cent, in the

two Surrey soils where the rock is so near the surface. The other fractions, particularly the clay, are equally variable. In some cases, as in the Sutton by Dover and Meopham samples, the clay is high; indeed, these soils would be very heavy working did they not contain so large a proportion of carbonate of lime. The only explanation that can be offered is that the different layers of the Chalk contain very different kinds of insoluble residue; in some cases a comparatively coarse material is left, in others nothing but the finest silt and clay. Again, the deeper loams on the chalk are by no means wholly derived from it, but contain much material arising from other formations which have been denuded away, such as the Thanet Beds and the Clay-with-Flints. The variation in mechanical composition affects the texture of the soils less than usual, so open are the finely grained ones kept by the high proportion of carbonate of lime.

The chemical analyses show that the chalk soils are rich in all the elements of plant food; their low productiveness in many places is due to exposure and lack of water rather than to poverty. For example, they contain both in soil and subsoil proportions of nitrogen which would not be expected, exceptionally high for arable soils not subjected to special treatment; the average percentage in the fifteen surface soils of which the analyses are given on pp. 186 and 187 amounts to 0·259 per cent, and five of the set are above this figure. The organic matter is often considerable, and the light colour of these chalk soils is no indication of lack of humus. At the same time the rapidity with which organic manures disappear is one of the characteristic features of chalky soils, as also is their special need for nitrogenous manures, so that one is driven to conclude that residues containing nitrogen, which render the soil apparently so rich, represent the last stages in the decay of organic substances, and consists of material which is now too resistant to bacterial decomposition to be of much service to crops growing on the soil.

Phosphoric acid is also generally above the average, because the chalk rock, itself an organic product, contains a fair proportion of phosphoric acid, and certain layers in the rock yield phosphatic nodules or coprolites. The available phosphoric acid, though variable, is generally low, because the large amount of carbonate of lime in the soil reduces the concentration of the soil water in phosphoric acid. Active phosphatic manures are very necessary for most crops on chalk soils.

Potash is present in average amounts, about half a per cent or less soluble in hydrochloric acid; again, however, the availability is not very high and potassic manures are more needed on the chalk than on the majority of soils.

The magnesia is only high in two cases, Nos. 59 and 213; in all the others it is low, nor does it bear any relation to the amount of lime also present. Iron is present in fair quantity, 2 to 3 per cent of oxide of iron; and alumina as usual is roughly proportional to the clay.

Manuring of the Chalk Soils.—The analyses demonstrate that there is no special deficiency to be remedied in the soils resting

on the Chalk, and experience shows that they should receive an all round manure appropriate to the particular crop to be taken. Moreover, despite the value of organic matter in such light soils, the more costly manures which contribute organic matter to ordinary soils waste away so quickly in chalk soils that but little may be expected from them after the season of their application. Hence the quick-acting soluble fertilisers, nitrate of soda and sulphate of ammonia as sources of nitrogen, superphosphate to supply phosphoric acid, and kainit to furnish potash, will give better profit than more expensive manures, and the lack of humus must be made up by folding or by ploughing in green crops. On this land roots are better grown without dung, which should either be put on the young seeds in the late autumn of the year they were sown, or a year later, before they are ploughed up for wheat. If much use is made of folding, and cake and corn are fed out to the sheep when on the land, farmyard manure may be dispensed with on the arable land, and little artificial manure beyond superphosphate for the turnips need be purchased. This system saves all the farmyard manure for the meadows, which on the Chalk are always greatly in need of dung. Speaking generally nitrogenous manures are very effective on this soil, though they are hardly so necessary as phosphatic manures, of which superphosphate should always be chosen. Basic slag does not answer on the dry alkaline soils of the North Downs in East Kent, and there is not moisture enough to make bone meal and similar neutral phosphates very effective. Kainit answers very well for mangolds, potatoes, and meadow land; a dressing of salt is often equally as effective in supplying the crop with potash.

On the South Downs the concentrated food supplied to the sheep on the fallow crop and on the seeds forms the basis of the manuring. Phosphates are commonly used, basic slag being generally found better than either bones or superphospates. Kainit is also useful. The sheep walks are not manured, and the system of bringing the sheep down by night must tend to impoverish them. Marked improvement has followed the use of basic slag and kainit on these pastures.

The following typical manures may be recommended for chalk soils:—

For Barley after wheat or other straw crop—

1 cwt. sulphate of ammonia.
3 cwt. superphosphate.

For Barley after roots folded off, a dressing of 3 cwt. of superphosphate per acre, harrowed in before drilling, improves both the yield and quality of the barley.

For Mangolds—

20 loads farmyard manure	drilled with seed.
2 cwt. superphosphate	
3 cwt. kainit	
1 cwt. sulphate of ammonia	
1 cwt. nitrate of soda	top dressing when singled.
2 cwt. salt	

For Swedes, &c., without dung—
- 2 cwt. fish guano.
- 4 cwt. superphosphate.
- ½ cwt. sulphate of ammonia.
- 3 cwt. kainit may be added where the chalk is near the surface.

For Potatoes—
- 20 loads farmyard manure.
- 3 cwt. superphosphate.
- 3 cwt. kainit.
- 1 cwt. sulphate of ammonia.

For Meadow Land—
- 1 cwt. sulphate of ammonia.
- 2 cwt. superphosphate.
- 3 cwt. kainit.

For Hops—
- 20 loads dung—winter.
- 15 cwt. rape dust
- 4 cwt. superphosphate } early spring.
- or 10 cwt. fish guano }
- 1 cwt. sulphate of ammonia or nitrate of soda may be applied early in June if the bine is short.

The above dressings are liberal and can only be used with profit on good land.

Above all, the Chalk soils are benefited by the occasional growth of sainfoin or lucerne, and by folding.

Grass Mixture on Chalk Soils.—In one year's ley on the Wye College Farm the following mixture has been found very successful:—

	Per acre.
Unmilled Giant Sainfoin	2 bushels
Red Clover	3 lb.
Alsike	3 lb.
Italian Rye Grass	2 lb.

On the drier soils it would be advisable to decrease the amount of alsike or leave it out altogether, substituting hop trefoil or black medick in its place.

For leys of from 4 to 6 years duration on similar soils—

	lb. per acre.
Lucerne	1
Milled Sanfoin	2
Red Clover	3
White Clover	1½
Black Medick	2¼
Italian Rye-grass	4
Perennial Rye-grass	8
Cocksfoot	3
Smooth-stalked Meadow-grass	¾
Tall Oat Grass	3½
Hard Fescue	1¼
Crested Dog's-tail	¾
	31 lb

Where the land is of a heavier character it would be well to decrease the Italian rye-grass and tall oat grass and add, say, 2 lb. of Timothy.

For permanent pasture—

	lb. per acre.
Lucerne	1
Milled Sanfoin	2
Red Clover	$2\frac{1}{2}$
White Clover	1
Kidney Vetch	1
Bird's-foot Trefoil	$\frac{1}{2}$
Perennial Rye-grass	8
Tall Oat Grass	6
Cocksfoot	3
Meadow Fescue	6
Smooth-stalked Meadow-grass	$\frac{3}{4}$
Crested Dog's-tail	1
Hard Fescue	$1\frac{1}{2}$
	$34\frac{1}{4}$ lb.

8. The Upper Greensand.

Distribution of the Upper Greensand.—Immediately below the Chalk Marl comes the Upper Greensand, a formation which is barely distinguishable in East Kent and only begins to figure in the landscape when we get as far west as Godstone in Surrey. Under the scarp of the North Downs, however, about Godstone, Merstham, Gatton, and Betchworth, a narrow terrace will be seen from which the land dips on the one side to the Chalk Marl that lies between it and the down and on the southern side to the Gault Valley. Close to the surface of the land on this terrace lie beds of a smooth, white, easily worked calcareous sandstone, a stone that was formerly of considerable repute for building, being much employed, for example, in the building of Westminster Abbey. There is also a thin bed of a less calcareous character which is valued for hearthstones. Further west the outcrop of the Upper Greensand becomes very narrow and is barely visible until Farnham is reached, beyond which town it broadens out and forms a considerable belt at Bentley and into Hampshire round the axis of the Weald. It is on this formation that Selborne lies and Gilbert White (1789) thus describes the strata—"The high part to the south-west consists of a vast hill of chalk, rising three hundred feet above the village; and is divided into a sheep down, the high wood, and a long hanging wood called the Hanger. . . . At the foot of this hill, one step or stage from the uplands, lies the village. . . . The houses are divided from the hill by a vein of stiff clay (good wheat-land), yet stand on a rock of white stone, little in appearance removed from chalk; but seems so far from being calcareous that it endures extreme heat. . . . To the north-west, north and east of the village, is a range of fair enclosures, consisting of what is called a *white malm,* a sort of rotten or rubble stone, which, when turned up by the frost and

rain, moulders to pieces, and becomes manure to itself. Still on to the north-east and a step lower, is a kind of white land, neither chalk nor clay, neither fit for pasture nor for the plough, yet kindly for hops which root deep into the freestone. . . . This white soil produces the brightest hops. As the parish still inclines down towards Woolmer-forest, at the juncture of the clays and sand the soil becomes a wet, sandy loam, remarkable for timber, and infamous for roads. . . . Beyond the sandy loam the soil becomes an hungry lean sand, till it mingles with the forest; and will produce little without the assistance of lime and turnips." White's "stiff clay" is the chalk marl, the white stone, malm, and freestone represent the Upper Greensand, while the "wet sandy loam" lies on the Gault with the "lean hungry" Lower Greensand beyond.

When the Upper Greensand enters our area again in Sussex at the foot of the South Downs it presents the same appearance of a terrace, never as much as a mile wide, slightly higher than the Chalk Marl which lies between it and the hill, and still more elevated above the Gault, now on its northern side. In West Sussex the villages are very generally built on the Upper Greensand terrace, though the parishes are cut at right angles to it in long strips which stretch from the top of the Chalk across both Upper and Lower Greensand, and on to or even beyond the Weald Clay. In this way each parish got its share of all the different kinds of land—sheep walk, pasture, woodland and plough-land, while the churches and settlements were fixed on the Upper Greensand because there good water could be obtained not far below the surface. It is generally easy to locate the Upper Greensand by the depth to which the roads have been worn in the soft rock. Fig. 34 shows the village of Harting on this Upper Greensand terrace with the Chalk escarpment beyond. As in Hampshire, the Sussex farmers distinguish between the white malm near the top and the hard blue malm or "rag" lower in the series.

Agriculture on the Upper Greensand.—Throughout its whole exposure from Godstone round to the sea near Willingdon, the Upper Greensand forms a somewhat heavy retentive soil, dark lead coloured or almost black when wet but drying almost as white as chalk land. In many places it is shallow and of no great value because of the rock below, but in the neighbourhood of Bentley and Farnham it is highly prized, especially for hops and wheat; there are also a few hop gardens on it in the neighbourhood of Midhurst, but they do not extend further into Sussex. Nearly all the land on this formation is in cultivation, very little wood and no commons or wastes being seen. The patch of Upper Greensand in Surrey, except in so far as it is covered by the grass of Gatton Park, is generally highly farmed and good crops are taken off it, especially of mangolds for the cows that are much kept in this district. Further west in Hampshire the land is also highly prized, though as remarked above, it is regarded as most suitable to wheat and hops. In Sussex it is not much used for sheep, being considered too heavy for folding, especially as the rainfall is considerable in this district. The farmers along the line of the Upper Greensand in

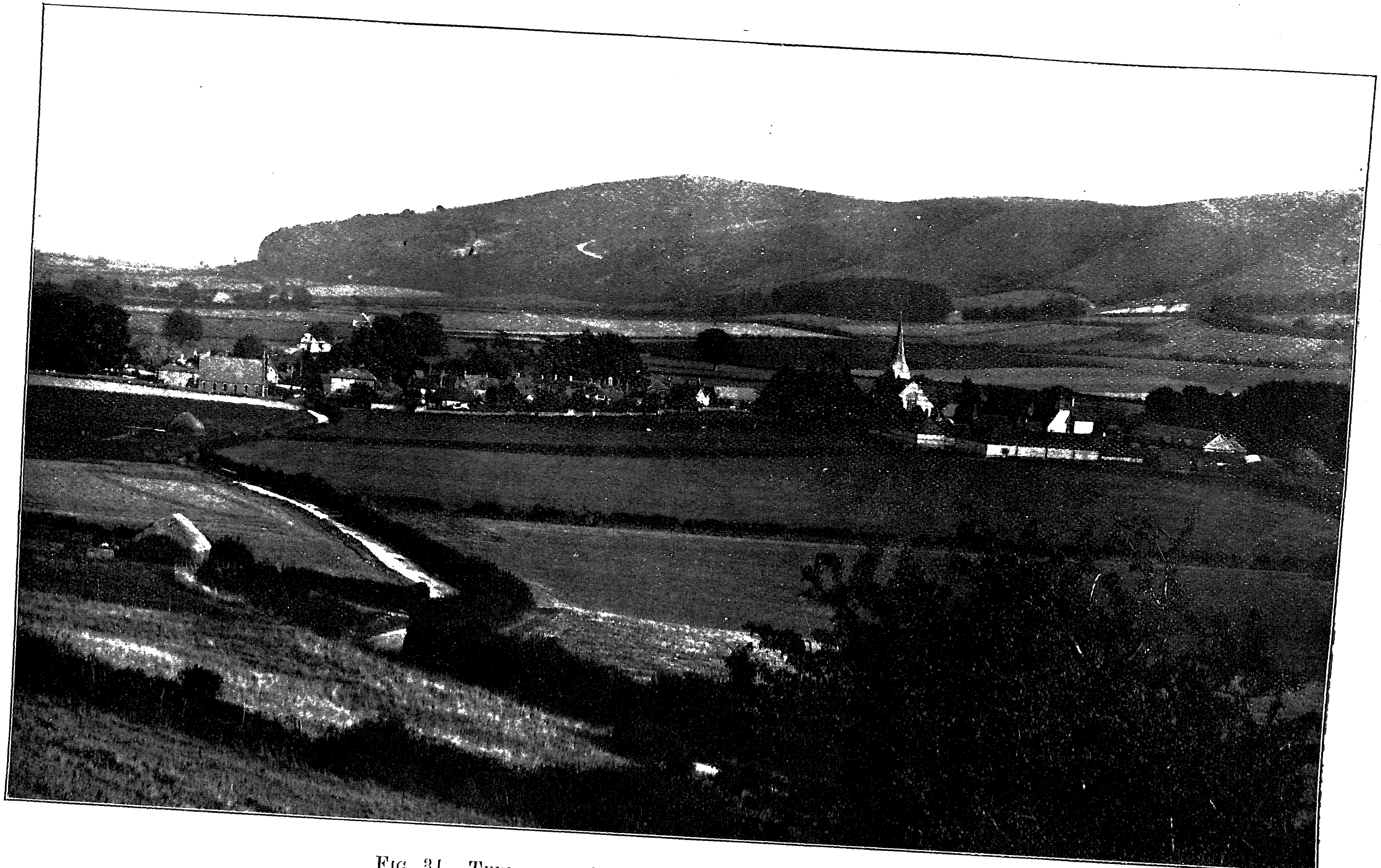


FIG. 34.—TERRACE OF UPPER GREENSAND, HARTING, SUSSEX.

(To face p. 108.)

West Sussex are nowadays chiefly concerned in producing milk; they follow a regular four-course rotation and draw the roots (mangolds and swedes) off for their cows. The climate is too wet for barley on a soil so retentive as this is, and [illegible] oats replace barley in the rotation.

The natural vegetation on the Upper Greensand closely resembles that of the Chalk: the same trees and shrubs [illegible], with the lower elevation and greater supply of water and shelter they grow much more rapidly than on the Chalk proper.

Composition of the Upper Greensand.—The mechanical analyses of soils on the Upper Greensand show a fairly constant type, though with some local variations which might have been expected from the differences existing between the top and bottom beds. The soils are well balanced and contain all the fractions suitably developed; their comparative heaviness and tendency to run in wet weather and to dry steely are due to the high amount of fine silt which all of them possess. They all contain some coarse sand, up to 5 per cent. but the fine sand is perhaps the most variable fraction of all, being as high as [illegible] per cent in the Buckland sample and falling to 24 per cent in that from Firle. The silt averages about 20 per cent. and the fine silt lies between 10 and 15 per cent, while the clay, which in most of the surface soils is about 12 per cent. runs up to double that amount in the Firle soil. The grading of the particles must be regarded as good and well suited to most crops, though rather on the heavy side for the rainfall met with in the western part of the area, especially as its situation in a valley under the Chalk rather leads water on to the formation. In some cases also the layers of impervious stone close to the surface interfere with the drainage, especially where they are bedded very horizontally as in parts of West Sussex.

From the chemical point of view the soils always show a sufficiency of carbonate of lime, as might be expected from the calcareous character of much of the rock and the aspect of the vegetation; but the actual amount is variable and not high in any of the samples examined. It may, however, be taken for granted that Upper Greensand soils are sufficiently provided to admit of the use of sulphate of ammonia, superphosphate and other acid manures, though experience has shown that lime [illegible] to ameliorate the physical texture of some of the soils.

The amount of nitrogen is rather high for arable soils, as is usually the case when much carbonate of lime is present; in the arable soils examined it varied from 0·15 to 0·20 per cent; the nitrogen of the subsoil is also over 0·10 per cent.

The proportion of potash is also high, being a little less than 1 per cent in the northern samples, but below 0·5 per cent in those from the southern area. Notwithstanding this fact the available potash is low, only from 0·01 to 0·02 per cent being found.

Magnesia is present in rather larger quantities than usual, from 0·4 to 0·6 per cent, but there is always less magnesia than lime, which varies from 0·8 to 2·6 per cent. Alumina as usual varies with the clay present, but the proportion of iron is distinctly low, varying from 2 to 3·7 per cent of ferric oxide. Manganese is found in comparatively large quantities, from 0·05 to 0·12 per cent.

The amount of phosphoric acid proves to be low, unexpectedly so in view of the occurrence of coprolites in the stratum and the statements of Way and Paine as to the dependence of value of this soil on its richness in phosphoric acid so derived. However, the available phosphoric acid is exceptionally high, varying from 0·02 to as much as 0·16 per cent.

Of sulphuric acid there is about the usual amount, 0·05 to 0·07 per cent.

The Upper Greensand in the neighbourhood of Farnham possesses a special interest in that it was the subject of one of the earliest investigations into the connection between agriculture, chemistry, and geology. In the Journal of the Royal Agricultural Society for 1848, 1851, and 1853, appear three papers by J. T. Way and J. M. Paine dealing with the composition of the soils lying between the Gault and the Chalk, as they were exposed on the second author's farm near Farnham. In the course of this investigation two remarkable facts were discovered about the Upper Greensand: firstly, that near the top there occurred a bed of green marl in which nodules containing phosphate of lime were abundant; and, secondly, that the lowest bed of this rock immediately above the Gault contained a very high percentage of silica soluble in dilute alkalis. It is of this latter rock that the authors write: "It is one of the richest subsoils of the whole chalk series, being admirably adapted for the growth of hops, wheat, beans, &c., and indeed nearly the whole of the outcropping of this subsoil from Farnham to Petersfield is under cultivation for the first named crop. When exposed to frost this rock crumbles to a fine powder. In the neighbourhood of Farnham, during the last ten years, many thousands of tons have been dug and used as a manure, under the impression that it was a 'good marl'; that is so far mistaken as regards the meaning of the word marl, which, correctly speaking, should only be applied to a substance containing much carbonate of lime." Way then went on to attribute the value of this rock to the very high proportion it contained, 30 to 60 per cent, of readily soluble silica, which he associated with the abundance of silica in the ash of the straw of wheat, the crop which did so well on this stratum. For some time the rock was mined as a source of soluble silicate manures, but its use died away as it began to be realised that the stiffness of straw does not depend on the silica, of which all soils appear to be able to furnish an abundance to the plant. Some of the rock is still mined, as it finds an outlet industrially.

The authors were also disposed to attribute the fertility of the soils on this formation to the phosphatic marl: "The circumstance which primarily induced our investigations into the nature of the peculiar green band of the Upper Greensand was the extraordinary fertility noticed in the crops where the outcrops of this singular marl occurred. . . . In the parish of Farnham the bed traverses its whole extent from east to west, coinciding with the line of the very best hop grounds—those which are perennially continued under hop culture." On digging this marl the actual fossils separated contained about 60 per cent of

phosphate of lime, and the whole mass could be separated by a seive into fine stuff containing 13 per cent, and coarse material which on grinding showed nearly 20 per cent of phosphate of lime. For some time these beds were dug for the manufacture of superphosphate, but the phosphatic layer proved to be too thin and poor to pay for working, even when the only competing phosphates were bones and the coprolites derived from Suffolk and Cambridge. Evidence of the existence of this phosphatic layer may be seen in the occasional high phosphoric acid content of the Upper Greensand soils, as, for example, that from Bentley (No. 84). Though the discoveries have not proved of lasting importance these papers by Way and Payne should be remembered as the first application of soil analysis to agriculture.

Manuring of the Upper Greensand; and appropriate Grass Mixtures.—The manuring and grass mixtures appropriate to Upper Greensand soils may be taken as identical with those recommended for the Brick Earths (p. 72), the only difference being that the Upper Greensand soils, especially in the wetter districts, should be regularly limed or chalked.

9. The Gault Clay.

Distribution of the Gault Clay.—The Gault Clay forms a narrow valley immediately underneath the southern edge of the North Downs. As the formation at its thickest is not much over 200 feet thick the outcrop is never very broad; between Ashford and East Wear Bay, near Folkestone, where it touches the sea, the Gault forms a shallow valley from one to two miles broad. Between Ashford and Burnham, thence on to Otford and to Merstham, the Gault outcrop is rarely more than a mile broad, and west of Merstham it gets much narrower, shrinking to a mere strip between Guildford and Farnham. West of Farnham, however, the Gault suddenly broadens out to its greatest extension in our district, and forms a tract of forest land running into Hampshire, known as Alder and Alice Holt. In Sussex it forms a well-marked strip of stiff land lying in the little valley between the malm terrace and the gradually rising lower Greensand. From Harting to Heyshot it is about a mile wide, then it narrows, but between Barlavington and Hardham a large patch occurs, and again between Ringmer and Ripe. A few small lateral streams take their rise where the clay throws out the water at the base of the Chalk, and run for a time along the outcrop until they join the main rivers, which cut transversely across the Gault and the Chalk, but it is only exceptionally that these streams run for any distance on the Gault itself.

The Gault forms a stiff tenacious clay often known locally as the "black land," and as it is almost wholly low lying, the Chalk rising on one side and the Greensand hills on the other, it is often wet and full of land springs.

The colour of the Gault Clay when seen unweathered in the pits and wet is nearly black in the lower beds, grey and marly above; it weathers into a brown soil, which dries very white when turned up with the plough in the upper beds, so that it is

often difficult to decide whether a given field lies on the Upper Gault or on the marl at the base of the Chalk. In consequence of the narrow outcrop it is rare to find an unmixed Gault soil. Sand creeps from the Lower Greensand, which is geologically below it, but which stands at a higher level; fragments of flint and chalk creep from the Downs, together with some of the sandy matter always found at the top of the Downs.

One feature of the Gault formation is the occurrence at various levels of thin beds full of "coprolites," nodules containing 40 to 60 per cent of phosphate of lime. These were at one time worked near Cheriton as a source of phosphate for the manufacture of superphosphate; but, in view of the many foreign phosphatic materials now available, these thin seams have long ceased to be dug at a profit.

Owing to the richness of many of the Gault beds in compounds of iron, wherever it is waterlogged there is a great tendency for oxide of iron to accumulate in a red earthy layer just below the black peaty soil; a rusty scum forms on the surface of the water in the ditches and is an unfailing sign of want of drainage.

Agriculture on the Gault Clays.—As a natural consequence very little of it is under the plough; some of it, especially where the pure clay has been modified by the washing of sand from the adjoining slopes, makes excellent pasture, though in many places the absence of drainage and the soakage of water from above results in a very sour soil, and even an accumulation of peat.

The most profitable use to make of Gault soils is to keep them or lay them down as permanent pasture; by drainage, liberal treatment with chalk, and occasional dressings of basic slag great improvements in the pasture can be effected.

Good oaks are grown on the Gault; some parts of Alder Holt on this formation have always been noted for their fine timber.

Composition of the Gault Clay.—The analysis of the Gault soils shows considerable variation, partly owing to the physical causes, rain wash, &c., enumerated above, and partly to the great difference in composition which exists between the upper and the lower beds.

While the lower beds consist of very pure clay and are almost without carbonate of lime, the middle beds become marly and pass by insensible changes into the Chalk Marl.

The most typical Gault soil, however, is deficient in calcium carbonate, all the samples analysed show less than 0·05 per cent of calcium carbonate except No. 39, which contains as much as 2·5 per cent; yet this is an undoubted Gault soil as shown by the examination of the subsoil.

The proportion of phosphoric acid also shows very considerable variations; sometimes the soils are deficient and contain less than 0·1 per cent of this most important constituent. Others, however, are well furnished with phosphoric acid, *e.g.*, No. 40, which contains as much as 0·253 per cent. In nearly all cases, however, the available phosphoric acid is low. The variation is undoubtedly due to the thin beds of coprolites to which allusion has already been made; wherever they happen to come to the

surface the proportion of phosphoric acid will rise, though the mass of the formation is poor in this respect. In the stones separated from the subsoil of No. 40 fragments of coprolites were detected.

The proportion of potash is high, amounting to nearly 1 per cent, but only a small fraction of this is in an "available" condition. The content of these soils in magnesia is low, less than 0·1 per cent, always less than the lime, forming in this respect a marked contrast to the lithologically similar soils derived from the London Clay, which often contain 1 per cent or more magnesia.

The proportion of soluble iron compounds is generally low; where undrained there is always a crust of oxide of iron found below the surface, though of a soft character; the ironstone gravel characteristic of some clays has not been met with in the Gault in our experience. Manganese is very low also. The sulphuric acid is about normal, about 0·07 per cent of the soil.

The mechanical analyses show very high proportion of clay and the finest silts, the only exceptions being with some of the soils from Alder Holt and West Sussex (Bepton), which on the surface are sandy, probably due to washing from the neighbouring hills of Lower Greensand. The subsoils, however, show all the characters of a pure unmixed clay. In East Sussex, where the Greensand ridge does not occur, the amount of coarse sand is only small.

Manuring of the Gault Clay Soils.—So little of the Gault is arable land that the question of suitable manures rarely arises. All this land, however, even the pasture, can be much improved by liming or by liberal applications of chalk. As the chalk is so near this can be done with a minimum of expense, and the number of small disused chalk pits which are to be seen close to the junction of the chalk and Gault point to a time when far more attention was paid to this important detail.

Despite the variations in composition to which we have drawn attention, the notes on liming, manuring, grass mixtures, &c., which have already been given for the London Clay (pp. 86-88) are generally applicable to the Gault, especially to the lower beds neighbouring the sand. But in the case of the Gault more than with most formations, it will be wise for the farmer to have a partial analysis made of individual fields to ascertain how far the proportions of carbonate of lime and phosphoric acid there present conform to the type.

Basic slag is likely to prove a very valuable manure on most of the Gault soils; the only one of the Wye College experimental plots which has been located on the Gault, fully bore out this opinion.

Where the land is waterlogged and sour, as shown by the iron stain in the water of the ditches, all attempts at improvements must begin with drainage. In some situations deep open ditches can be dug to cut the land springs and draw off the water; in other cases a regular system of under drainage is alone effectual. Once drained, the land must be well dressed with lime to correct the sourness and precipitate all the soluble iron compounds, and further dressings of basic slag will help to bring the land into good condition.

10. The Lower Greensand.

Distribution of the Lower Greensand.—It has already been described how the group of sandy formations known as the Lower Greensand forms a second range of hills, within and parallel to the incomplete oval of the Chalk escarpment. The sandstone hills, like the Chalk and for the same reason, present a steep scarped slope towards the core of the Weald and a longer gentle slope on the other side, in this case to the Gault valley which separates them from the Chalk.

The starting point of the Lower Greensand is a hill or ridge called Rake Hanger, about 500 feet high, three miles or so east of Petersfield on the Portsmouth Road; the crest of the hill is just inside the Sussex boundary and from it north-eastwards extends one ridge in a continuous line of hills as far as Folkestone and Hythe, while its counterpart starts out in a south-easterly direction. This southern ridge, after forming one stretch of high country a little north of Midhurst (where it is the site of the King Edward VII. Sanatorium for consumptives), and a lower and smaller patch east of Petworth, ceases to be any feature in the landscape east of the Adur. The formation then becomes much thinner, so that its outcrop is rarely more than a mile wide in the stretch between the Adur and the Pevensey Level in which it terminates, nor is its general level sensibly higher than that of the Weald Clay to the north or the Gault to the southward.

The northern ridge of the Lower Greensand pursues a very different course; a few miles from its starting point it suddenly broadens out into an extensive area of hill and heath about twelve miles broad from north to south between Farnham and Fernhurst, and about ten from east to west, between the edge of Woolmer Forest and the outskirts of Haslemere. In this patch the highest points are near the edge of the escarpment overlooking the Weald Valley, where the ridge reaches the height of 918 feet on Blackdown and 895 feet on Hindhead. Beyond Thursley the sand is only about six miles wide until it is traversed by the Wey and its tributaries south of Guildford, after which the ridge, reduced to a width of four miles, again becomes more elevated and culminates in Leith Hill (965 feet), the highest point in the south-east of England. For some distance east of Leith Hill the Lower Greensand has been so denuded away by the River Mole that it is only distinguishable by the nature of the soil, but about Reigate Heath it is again discernible as a low narrow ridge of friable sandstone, which broadens a little by Bletchingly and Tandridge, until between Limpsfield and Ightham it again forms an elevated tract, about twelve miles long and two broad, reaching a height of 700 feet at Crockham Hill on the edge of the escarpment. Beyond Ightham for about twelve miles the outcrop broadens a little until it is about six miles wide in the neighbourhood of Maidstone, where the Medway has cut a deep valley through the rock, but in this region, in which the rock is known as the Kentish Rag or Ragstone, a height of 500 feet is only reached at one spot

Fig. 35.—Lower Greensand Escarpment, near East Sutton, Kent.

(To face p. 115.)

and no great amount of country is over 400 feet. The escarpment above the Weald Clay plain, however, is still well marked (*see* Fig. 35) for some distance east of the Medway, but as the Stour Valley is approached the level of the country continues to fall, and between the Stour and the sea the Greensand is but little elevated above the Wealden area, the cliff behind Hythe being rarely 300 feet above sea level.

Agriculture on the Lower Greensand.—The Lower Greensand has been divided into four distinct formations—the Folkestone Sand, the Sandgate Clay, the Hythe Beds, and the Atherfield Clay—which can readily be differentiated along the face of the sea cliff between Folkestone and Hythe, but which become much confused further inland. The uppermost layer is called the Folkestone Sand and forms much the most coarse-grained member of the series, and one which persists without change all round the outcrop of the formation. Being the nearest to the valley formed by the Gault, the Folkestone Sand is rarely very elevated, though in the west, where the formation attains its maximum thickness, it runs up to 534 feet on Crooksbury Hill south of Farnham. Despite its lower elevation the Folkestone Sand is so coarse-grained and devoid of carbonate of lime that a very considerable portion of it is uncultivated and its outcrop all along is marked by heaths and commons. East of the Stour the Folkestone Sand is mostly cultivated, though Brabourne Lees is still unenclosed; further west on this formation come Hothfield Common, Charing and Lenham Heaths, and though in Mid-Kent it is not well developed, from Ightham onwards it is marked by a row of commons. In West Surrey the extensive common of Blackheath, and much of the heath and woodland close by, lie on the Folkestone Sand; a little further west comes the great extension of the Folkestone Sand in the waste heaths and pine woods to the north and west of Hindhead—Puttenham, Crooksbury, Thursley, Frensham, and Farnham Commons, leading on into Woolmer Forest. On the southern arm of the Lower Greensand the Folkestone Sand is distinguishable as far as the Adur, and carries common land at Westheath, Trotton, Cocking, Lavington, Stedham, &c., but west of the Adur the Lower Greensand is no longer divisible into separate formations, though a thin bed of building sand which is worked near the Weald Clay in places probably represents the Folkestone Beds. Fig. 36 shows the typical vegetation on one of these barren heaths on the Folkestone Sand. All along its outcrop the Folkestone Sand is dug for building; in one or two places in East Kent and at Reigate it is very white and is worked for glass making purposes, this glass sand being rather more coherent than usual, so that it can be dug in caves.

All these heaths and commons on the Folkestone Sand are very much alike, sour black heaths carrying a natural vegetation of heather and heath, with patches of the tufted Purple Molinia (*Molinia cærulea*, Mœnch.) and various drought-resisting grasses, and other patches where the bleached sand breaks through the black peaty soil. Dry as the surface generally is water accumulates in some of the hollows, held up by an iron pan or

some thin parting of clay, and in these hollows peat forms, while such characteristic plants grow as the Bog Asphodel (*Narthecium ossifragum*, Huds.), the Sundew (*Drosera rotundifolia*, L.), Cotton Grass (*Eriophorum polystachion*, L.), and Sphagnum Moss (*Sphagnum*, sp.).

In the west much of the land has been planted or has sown itself with Scotch and Austrian pine, but in Kent plantations of Sweet Chestnut are more common because of its former ready sale for hop poles, fencing, and wattles. The Birch and the Holly are also common trees, with Ash in some of the wetter bottoms.

The intermediate Sandgate Beds possess a much heavier character than the Folkestone Sand; they are sometimes termed Clays, but on analysis the percentage of clay proves to be small, though there are one or two partings of impermeable material which serve to throw out the water which has percolated through the Folkestone Sand. The Sandgate Beds are thus distinguished as the water-bearing stratum of the Lower Greensand: for example, the two streams which unite to form the Stour at Ashford both run for some distance on the Sandgate Beds, one from the east and the other from the west; the Len, a tributary of the Medway, flows in a valley of which the floor is formed by Sandgate Beds; and in the west the valley of the Wey above Godalming, and the Rother above Midhurst may be equally associated with the Sandgate Beds. Lithologically they are hardly distinguishable from the beds above or below them, differing as much among themselves as they do from the Folkestone or the Hythe Beds. The only agricultural difference is that they carry a good deal of pasture along the wet bottoms. In a part of our area deposits of Fuller's Earth occur and are extensively worked in the beds in the Lower Greensand at Nutfield which, from their position, are attributed to the Sandgate series.

In the Godalming district occurs a bed of calcareous rock, the Bargate Stone, of some local repute for building, which from its position may also be reckoned as belonging to the Sandgate Beds, and this gives rise to a distinct type of soil. On the Bargate Stone lies a highly farmed area in the valley of the Wey west of Godalming, the soil being a light free-working loam, cropped on a four course rotation, but with a good deal of irregular catch-cropping, for the production of corn and the winter fattening of sheep which are brought in from the west country. The soil is too hot and dry for sheep in the summer, but stands folding admirably, and the whole system of farming centres round the sheep.

Below these Sandgate Beds comes the main division of the Lower Greensand, the Hythe Beds, which form the escarpment and the highest land all round the area, and contribute the most valuable soil belonging to the whole series. The Hythe Beds show very great lithological differences in passing along the escarpment and these are correlated with similar differences in the agricultural value of the soils. From Hythe itself as far as the valley of the Stour the Hythe Beds consist of calcareous rock, the Kentish Rag, interspersed with softer beds of a more argillaceous nature, the whole giving rise to a rather heavy

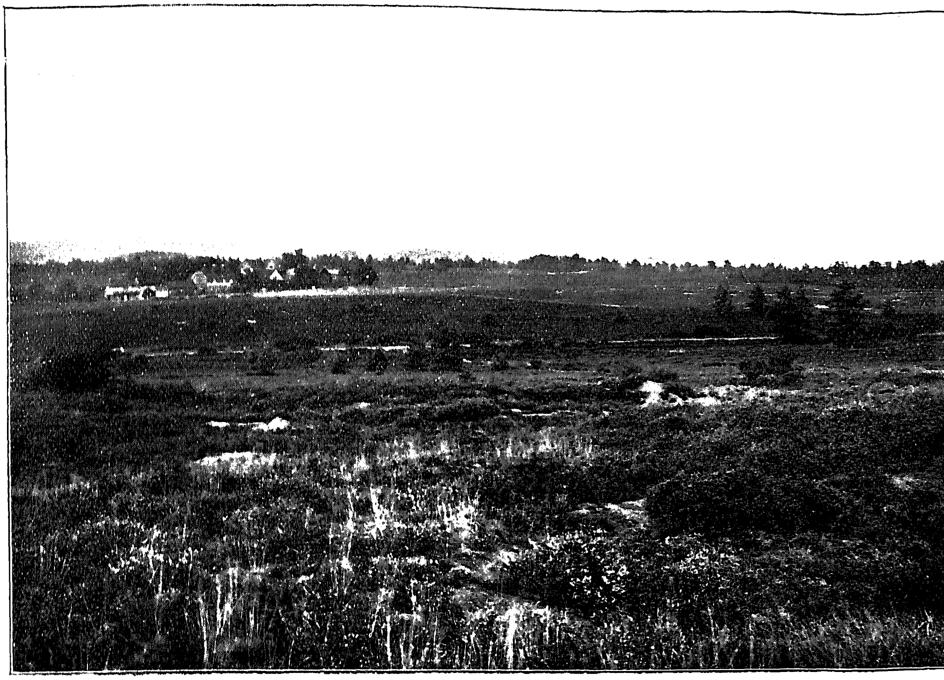


Fig. 36.—Barren Folkestone Sand at Blackheath, Surrey.

Fig 37.—Undulating Country, Lower Wealden Beds.

(*To face p.* 116.)

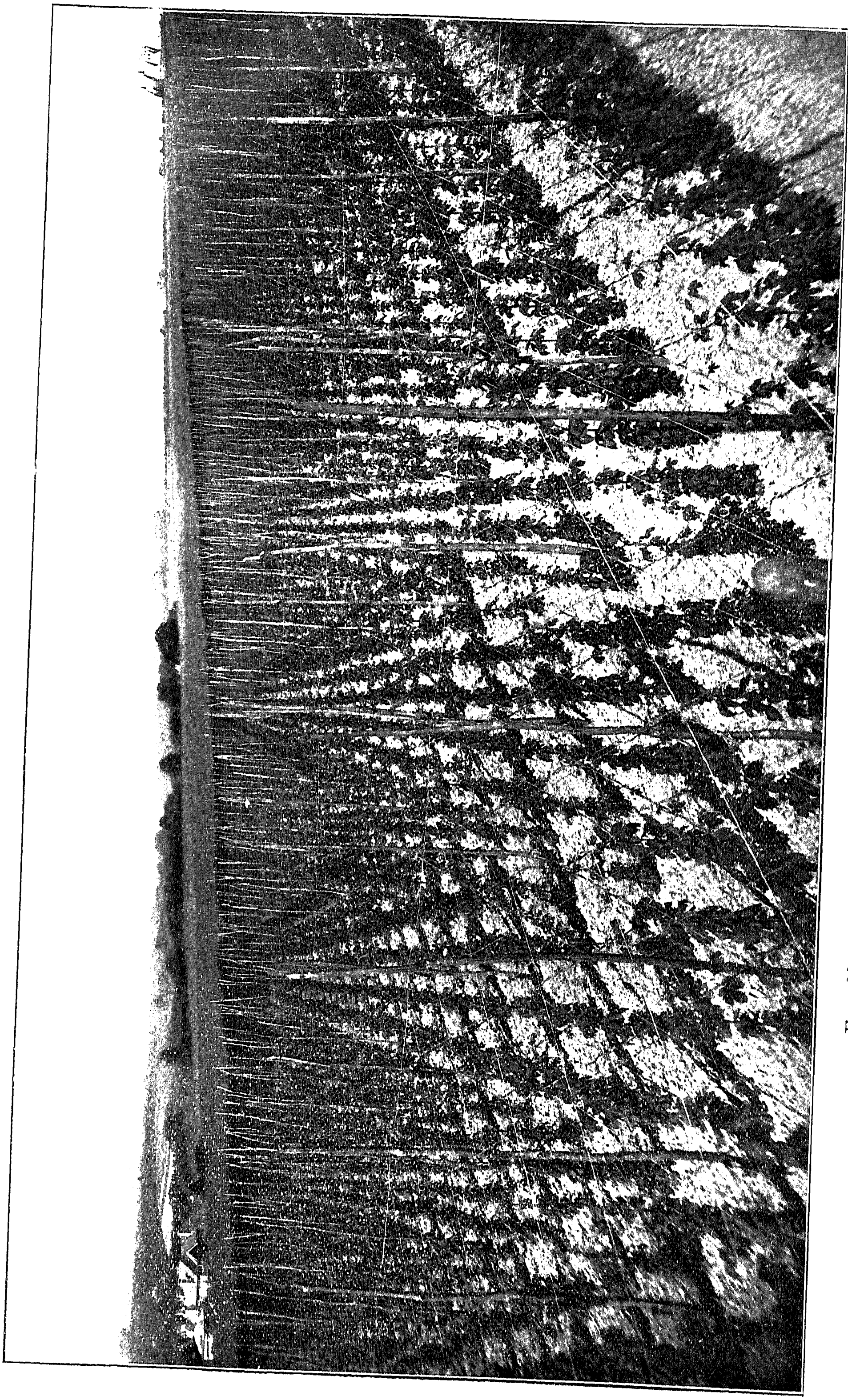


FIG. 38.—HIGHLY FERTILE REGION. HYTHE BEDS, MAIDSTONE.

(To face p. 116.)

loam useful for all kinds of farming. Similar soils persist on the other side of the Stour, but from Boughton Malherbe westwards the elevation increases and the soils become lighter and more easily worked. It is here that the famous "ragstone" country begins; fruit and hops become the dominant features in the landscape, and except for the plantations of chestnut from which the hop poles used to be drawn, the whole of this undulating country is thickly occupied and intensively farmed. The beauty and variety of the scenery, especially when the fruit trees are in bloom, can hardly be exaggerated. Fig. 38 shows a typical view taken in this district. The Medway Valley from Maidstone to Wateringbury forms the heart of this district; along the lower slopes are the finest of the Mid-Kent hop gardens, distinguished equally by their heavy crops and the quality of the produce. The soil is a free-working loam containing an abundance of flat fragments of rock, known as "pinnock." Higher up fruit is more abundant and of late years has been steadily replacing the hops, especially on the crest and southern face of the escarpment. Some of the land near the top of the ridge, Coxe's Heath for example, is very light, but the removal of a bed of thin stone close to the surface has enabled great areas of it to be taken into cultivation comparatively recently. Apples on the free stock, plums, gooseberries and currants, with filbert and cobnuts on the highest soils close to the rock, form the staple products of this region, cherries and strawberries being but little grown. Nearly all the fruit land is under tillage, grass orchards being less common than in East Kent. The rest of the farming is entirely subordinated to the fruit and hops; no regular rotation is followed, sheep are not much seen except for depasturing the grass orchards, but a certain amount of stock is kept to make dung for the hops, because the distance from the rail makes London dung an impossibility in most cases. The rich "ragstone" country continues as far as Mereworth, where, however, a large proportion of the land is still occupied by wood; beyond Mereworth the little tributary of the Medway which comes down from Wrotham marks the beginning of a less fertile type of country. West of this point the Hythe Beds round Sevenoaks contain less calcareous matter and consist of beds of hard stone alternating with loose sand, locally termed "hassock," while the soils become increasingly sandy the further one goes west. In the Sevenoaks country itself, though some fruit and hops are seen, they are by no means prominent and bear no particular reputation; a large proportion of woodland is seen and on the heights near the escarpment open commons begin to appear, as at Crockham Hill and Limpsfield. In this area the Hythe Beds give rise to a purely sandy soil, and though the outcrop is but sparingly developed between Limpsfield and the Mole, the soils retain the same character. West of the Mole the formation suddenly assumes considerable importance, and the great masses of Leith, Holmbury, and Pitch Hills, which are continued across the Wey by Hascombe Hill, and then by Hindhead and Blackdown, all consist of Hythe Beds. In this western region the soils derived from the Hythe Beds require close examination to separate them

from those derived from the overlying Folkestone Beds; both are pure sands, equally devoid of clay and carrying the same barren vegetation of heather and gorse, birch, and pine (*see* Fig. 40). To the farmer and botanist the whole of the Lower Greensand in this district may be treated as one, and the Hythe Beds have entirely lost the character which enabled them to give rise to some of the richest soils in Kent. On the line of the escarpment and for some little distance back Henley and Verdley Hills continue the formation round the southern side of the fold, where the escarpment for a few miles looks north-west across the Weald to the corresponding escarpment of Blackdown, but further east the Lower Greensand formation thins out and the outcrop is only distinguishable by the character of the soils.

From Midhurst to the valley of the Arun the Hythe Beds give rise to light but cultivable soils, on which some fair barley is grown.

The Kentish Rag provides one of the few hard building stones that occur in the district; it is very hard and never a freestone, so that it cannot be used for mouldings or fine work of any kind, indeed can only be roughly dressed to shape, but it stands the weather admirably and acquires a good texture and colour. West of the Medway Valley layers of very hard chert occur in the Hythe Beds and are used locally for road stone, but in West Surrey and Sussex the Hythe Beds only occasionally contain beds of red "car-stone" which can be used for building. The old builders, however, in this district were in the habit of decorating the mortar partings in their walls with the flat chips of this brown stone, until as Gilbert White says: "strangers sometimes ask us pleasantly, whether we fastened our walls together with tenpenny nails."

Below the Hythe Beds comes the remaining division of the Lower Greensand—the Atherfield Clay—a stiff blue clay, the marine fossils of which distinguish it from the Weald Clay below. The Atherfield Clay is never thick, and as it crops out on the steep face of the escarpment formed by the Hythe Beds, it merges in the Weald Clay, and as far as soil goes cannot be separated from it. The Atherfield Clay has been credited with giving rise to a very fertile belt along the face of the escarpment called "Coombe," but this is no more than the mixture formed by the downwash of the sand above on to the clay, thus forming a well tempered heavy loam in place of the pure clay beyond; its fertility is also helped by the water percolating through the sand and thrown out where it meets the clay.

The Lower Greensand ridge from Sevenoaks westward consists wholly of light sand and forms perhaps the most favoured residential area in the south of England. Considerable elevations are attained with a comparatively light rainfall, the coarse grained pervious sand drains quickly and is always dry, while the bold diversified surface and the wild open heaths are full of charm to a sophisticated people who have lost the farmer's point of view which prompted Cobbett to describe this country as "villainous wastes." The southern face of the Greensand escarpment is perhaps the best sun trap in England, and certainly no finer view

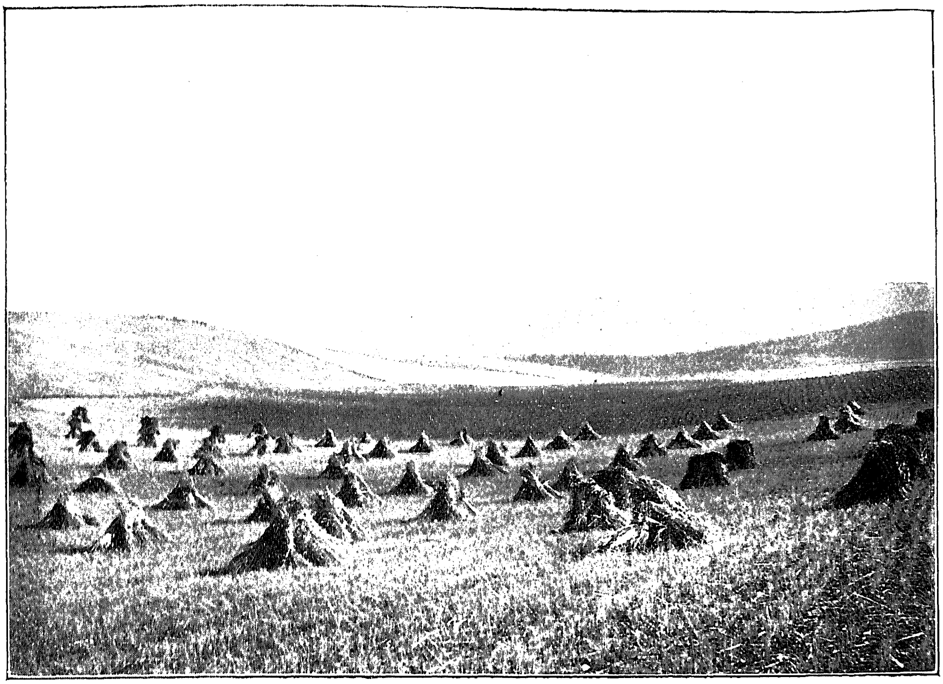


FIG. 39.—VIEW OF OPEN SOUTHDOWN COUNTRY NEAR LEWES, SUSSEX.

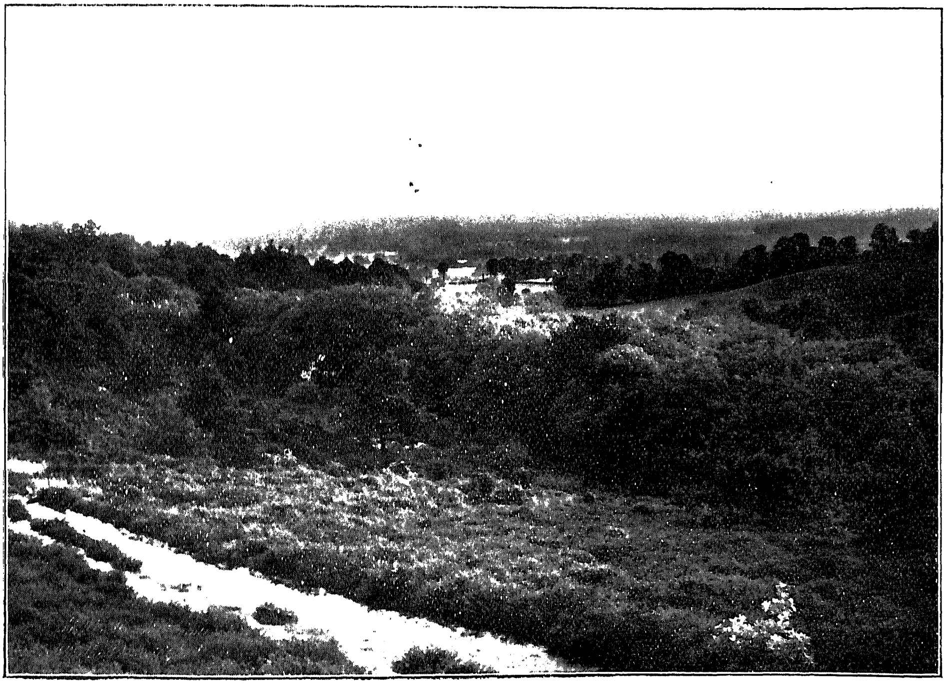


FIG. 40.—WOODED COUNTRY ON LOWER GREENSAND, LEITH HILL, SURREY.

(To face p. 118.)

can be found than the great sweep of the Weald below, rising in the distance into the wooded ranges of the Forest Ridge: "Green Sussex fading into blue." The scenery is at its finest at the western end; there the escarpment attains nearly its greatest elevation and dips very sharply down to the plain; this plain too is narrow, and across it one sees the corresponding deeply wooded ridge of the Greensand and beyond that in striking contrast the smooth line of the South Downs with their gently swelling heights and softly rounded coombes.

Composition of the Lower Greensand.—The uncultivated Folkestone Sands, when subjected to mechanical analysis (p. 190), show very great uniformity, the sample from Hothfield Common being almost identical with that from Blackheath and again with that from Down Park, near Rogate. About 85 per cent of the soil is composed of the sand fractions, and the coarse sand forms the greater portion, 60 per cent or more; we meet with no other soil containing such large proportions of coarse sand, not even on the Bagshots. Silt and fine silt together only amount to 7 or 8 per cent, while clay is less than 1 per cent. Calcium carbonate is absent: indeed, these heaths always show an acid peaty vegetation; at the same time the sands are bleached at the surface and deposit an iron band a foot or so below.

From the chemical point of view these soils, like those of other barren heaths, are marked by their small proportion of soluble material. The nitrogen and organic matter are very variable in amount, according as the conditions of situation and drainage have favoured or not the accumulation of peaty vegetable matter. The potash is very low, sometimes exceptionally so, though as is often the case with sour heath soils a relatively large proportion of it is soluble in dilute citric acid. The magnesia lies between 0·07 and 0·14 per cent, and is always less than the lime; the alumina is naturally low in soils containing so little clay, and the iron is low also despite the rusty colour of many of the soils. In one or two cases in West Surrey the proportion of oxide of iron is exceptionally high and runs up to 6 per cent: some of it is generally combined as a ferrous salt. The manganese is too small in amount to be estimated. The phosphoric acid is very deficient; rarely as much as 0·10 per cent is to be found, though as with the potash a relatively large proportion of it is to be found in an available condition. Sulphuric acid is a little less than usual but varies between 0·2 and 0·6 per cent.

The second part of the Table consists of analyses of cultivated soils, which belong in the case of Monk's Horton, No. 78, certainly to the Folkestone Beds, but in the other cases possibly to the Sandgate series, since they occur somewhere about the middle of the formation. The Nutfield soils, Nos. 101 and 102, were taken on the same horizon as the Fuller's Earth Beds; the Buckland soil, No. 82, was mapped as on the Folkestone; the Shalford soil, No. 124, as on the Hythe Beds; and the Eashing soil, No. 203, as on the Bargate Stone; all, however, have one feature in common with the uncultivated Folkestone Sands, the presence of more than 40 per cent of coarse sand. In fact, they resemble

the barren Folkestone soils in every respect, except that they are a little heavier all round, and contain less coarse and fine sand, more silt, and about 7 per cent of clay, which indeed rises on the Buckland soil to 12 per cent. The soils in this group are all very light, near the limit of profitable cultivation, but when well managed and thoroughly manured, and consolidated by the folding of sheep, they will grow fair crops, including barley of fine quality, good potatoes, and small fruit, especially strawberries. Winter fattening of purchased sheep and early lambs is the mainstay of the farmers on these soils in West Surrey, and there is nothing like the treading of the flock to keep the land in good order; if left loose the soil is so light that it has been known to blow right away from the roots of the young corn until the crop blew away also. As on all very light soils it is better to let the land carry weed vegetation through the winter if catch-crops are not being grown; the weeds help to save nitrogen and there is no urgency to get the land ready, since a single cultivation in almost any weather will secure a tilth. Sowing should be early and manures should be put on as late as possible in small quantities for the crop that is immediately to follow; large quantities intended to last over several crops in the rotation should never be applied.

The soil from the Bargate Stone, which is included in this group, is typical of a good deal of land in the neighbourhood of Godalming, which possesses a considerable reputation for fertility. It is light and easily worked, though it possesses more consistency than the other Greensand soils by which it is surrounded and will dry steely if worked when quite wet. Though the Bargate Stone, which is a calcareous sandstone, is close to the surface, the soils are still poor in carbonate of lime, and lime, which is brought from the chalk escarpment near Betchworth, is known to be effective. Winter fattening of sheep (they cannot be bred) forms the mainstay of the farming; they are folded on the turnips; and oats are generally taken afterwards, good barley being grown after wheat for which London dung has been applied. Very little care is taken about rotations, catch crops to suit the season being general. Potatoes are not much grown, and the land does not lay down to grass easily, while red clover is only successful at intervals of seven years or more. The manuring is largely done by cake-feeding the sheep when folding, but London dung is bought for the wheat, sulphate of ammonia and superphosphate are used for barley, and kainit is found to pay with mangolds. Basic slag has little effect.

One peculiarity of this Bargate Stone country is the way the fields are separated by great earth banks on the top of which hedges are planted; a similar feature is common in Devon, where banks are supposed to have been erected to keep out the deer.

From the chemical point of view the most notable deficiency in all these soils is carbonate of lime. From every district on this formation "finger-and-toe" is reported among turnips, cabbages, &c., and the prevalent weeds, Sheep's Sorrel (*Rumex Acetosella*, L.), Corn Marigold (*Crysanthemum segetum*, L.), and

Spurrey (*Spergula arvensis*, L.), all indicate an acid soil. Chalk, which is not far away, makes a better dressing than quicklime; if the latter be used it should be applied frequently but in small quantities, 10 cwt. per acre at a time. Potash is found in these soils in somewhat inadequate proportions, varying between 0·2 and 0·4 per cent; the available potash is also low, rarely as much as 0·02 per cent. Magnesia is higher than in the barren Folkestone soils, 0·2 to 0·4 per cent, and is but little less than the lime, which varies between 0·2 and 0·5 per cent. Alumina, like the clay, is low, but the iron is high, from 3 to 6 per cent of ferric oxide; of manganese there is only a trace. Phosphoric acid is relatively abundant, rising in the Monk's Horton soil (No. 78) to the exceptional amount of 0·493 per cent: the soils are also rich in available phosphoric acid, a fact in the main due to the high state of cultivation of most of those selected for analysis. There is about the normal amount of sulphuric acid for light soils, about 0·04 per cent. All the recommendations for manures on Bagshot soils apply equally well to these Folkestone Beds.

The table on p. 192 deals with a few soils that by their geological position are derived from undoubted Sandgate Beds, and their composition at once shows them to be distinct from the Folkestone Sands. These beds possess a much smaller proportion of coarse sand, only in the Godington soil does it reach 20 per cent; the fine sand is larger in amount, and the silt fraction begins to assume considerable proportions. The clay varies from 12 to 15 per cent in the subsoil, so that the soil is no more than a moderate loam, although the layers of an impervious nature in this rock throw out the water and have earned the name of Sandgate Clay for the formation. In East Kent little need be said about the farming of the Sandgate Beds, for they are not distinguished from the other soils on the Lower Greensand except where they are wet and are left in pasture; the whole of the Lower Greensand country east of the Stour is under ordinary mixed farming and is not particularly well done. In mid-Kent the Sandgate beds are not distinguished, and putting aside the Bargate beds it is not until the valley of the Rother between Rogate and Midhurst is reached that they possess any agricultural significance.

In West Sussex "the fertile and beautiful valley," as Marshall calls it, of the Rother is mainly occupied by Sandgate Beds, it is a distinct stretch of loamy soil lying between the light cultivated sands of the Hythe Beds to the north and the barren Folkestone Sands, which are largely woodland and common. The Sandgate Beds are highly farmed, chiefly for sheep, though cow-keeping for milk to despatch by rail is increasing; the sheep are winter fed on the land, on which they are supposed to do better than on the Upper Greensand. The land is easy to work, but must be ploughed before winter and sown early, as it suffers from drought and does better in wet than in dry seasons; it is always the better for consolidation either by sheep or by ring rolling. Nearly all the land is under the plough, and as on most light land weeds, especially Poppies, are abundant; Charlock is little seen but Knot Weed or Wire Grass (*Polygonum*

type, and on the thin soils potash should also be used, especially for stone fruit. It should be noted that lucerne grows well on these Ragstone soils and might be more extensively cultivated.

The remaining Table of analyses of soils on the Hythe Beds deals with those west of the Kentish Rag district, many of them being taken from the open unclosed heaths which characterise the Lower Greensand after it has entered Surrey.

As far as appearance, vegetation, and agriculture are concerned there is nothing to distinguish these barren sands lying upon the Hythe Beds from the neighbouring Folkestone Beds, but the mechanical analyses show one persistent difference: in the soils from the Folkestone Beds the coarse sand is the dominant fraction, constituting as a rule from one-half to two-thirds of the soil, but in the sandy soils from the Hythe Beds the coarse sand only amounts to about 10 per cent, and the fine sand now makes up the bulk of the soil.

No more detailed account need be given of these soils; all that has been said about the Folkestone Beds applies to them, the distinction between the two formations being of no practical importance from Leith Hill westwards.

The Hythe Beds continue to show this sandy character, devoid of the finer fractions of soil, up to the western extremity of the formation and round the southern side as far as Midhurst and Petworth. Eastward of that point the loamy character again begins to return, as may be seen from the analysis of soil No. 228 taken at Ripe in Sussex. From the Arun Valley eastward to Pevensey Level the Lower Greensand, which is no longer divided up by the Geological Survey, and is but little elevated above the adjoining clay formations, preserves this character of a free-working loamy sand. The soil possesses a considerable reputation locally as "the best land anywhere about" and is well farmed; it is extremely light and can be safely worked when it is soaking wet; it will carry all kinds of crops, the lightness being compensated for by a comparatively heavy rainfall. The production of milk for the London and coast town markets is the staple industry all along the strip; heavy crops of mangolds are grown and some of the land is down in grass. Malting barley is also grown, especially by the men who make sheep farming their chief business.

The mechanical analysis of one of these Greensand soils in its eastern extension in Sussex shows rather a different type from anything occurring elsewhere on the formation, and resembles the Sandgate soils more than anything else. It contains less coarse sand than most of the Sandgate soils analysed, and not quite so much silt, though the silt is still a large fraction.

The recommendations for manuring, &c., given for the Thanet Beds would apply to this strip of land.

11. The Weald Clay.

Distribution of the Weald Clay.—Below the Lower Greensand escarpment occurs one of the sharpest and most sudden transitions of soil and scenery experienced in the whole area, when the elevated and variegated sand country that has just been

Fig. 41.—View over the Wealden Plain from East Sutton, Kent.

described gives place to the uniform flat plain occupied by the heavy Weald Clay. This Wealden plain is an area of true Clay, the wetness and heaviness of which is aggravated by its general flatness and low elevation, causing the natural drainage of the country to be poor. From the heights the Weald Clay looks quite flat (Fig. 41), but in crossing it certain low ridges are perceived. These ridges are chiefly formed by thin beds of limestone, composed of *Paludina* and other fresh water shells. Being the only stone within the district this limestone was at one time very generally worked under the name of Bethersden or Petworth marble, and was used for pillars and steps in the churches, as in the steps leading to the Choir in Canterbury Cathedral, and for mantel-pieces and floors in the houses of the Weald. Many of the causeways for foot passengers, which were formerly characteristic of this region of very bad roads, were paved with slabs of the limestone. It takes a fair polish and has a pleasant grey variegated aspect, very similar to that of the Purbeck marble, so much used in churches of the Early English period, for which indeed it is generally mistaken. It does not appear to have been worked for many years now.

The Weald was never highly farmed and has always been regarded as poor backward unimproved country, the more so by contrast with the highly cultivated sand and alluvial soils close at hand. Most of the old arable land has sunk back to grass within the last generation, so that little besides grass and woodland is now to be seen. Owing to the small size of the enclosures and the prevalence of hedgerow timber the Weald plain seen from the heights appears to be more heavily wooded than is really the case. More on the High Weald, but still to a certain extent on the Weald Clay, one can recognise the old "shaws"—fields cut out of the woodland but still retaining a deep belt of copse wood all round; in most places the hedges and timber are far too extensive for the good of such heavy land, shading it from the sun and wind, especially if it is under the plough. Marshall writes of the Weald of Kent in his day—"of the state of husbandry in this part of Kent, I have only to say that there were many foul lands in the parts I went over—that the proportion of arable lands appeared to be much too great, and that the hedgerows were far too high, wide, and impervious to the winds for a low, dirty, arable country."

Agriculture on the Weald Clay.—In East Kent the Weald Clay begins in a series of low cliffs, formerly sea cliffs, overhanging Romney Marsh between Bonington and Woodchurch, its elevation being about 150 feet above sea level. It forms a belt about five miles broad running in a westerly direction as far as Tonbridge. This country is all of a gently undulating character and the greater part of the farming land is under grass; on the arable land wheat, oats, beans, and some mangolds are grown, but neither turnips nor barley. No regular rotation is followed; the leys are often left down for two years; and a bare summer fallow is necessary from time to time.

The grass land is of a very poor character, being chiefly made up of various forms of *Agrostis*, Crested Dogstail (*Cynosurus*

cristatus, L.), Cocksfoot (*Dactylis glomerata,* L.), Yorkshire Fog (*Holcus lanatus,* L.), with Rye Grass (*Lolium perenne,* L.) and Rough Stalked Meadow Grass (*Poa trivialis,* L.) in the better patches. Meadow Barley, locally known as "Squirrel-tail" (*Hordeum pratense,* Huds.) is common in places and *Aira cæspitosa,* L., marks wetter spots.

The better farmers in the Weald are chiefly breeders of Romney Marsh sheep and Sussex or cross-bred cattle. The sheep map (Fig. 54) shows how dense the sheep-breeding is to the south of Ashford. A fair amount of cow-keeping for the sale of milk takes place, as may be seen from the map showing the distribution of dairy cattle (Fig. 53), but the comparative lack of railway accommodation prevents the development of this industry. There is some good farming in the Weald, but the bulk of the farms are small, poor, and impoverished: men take a crop of hay off the poor grass land year after year with the help perhaps of a little nitrate of soda, the hay is partly if not wholly sold away, and sheep are then taken in to keep for the winter and only in the worst weather allowed a little of the hay that has been harvested in the summer. A continuance of this style of farming soon results in the most miserable grass land imaginable. A few acres of hops on the farm also contribute to its general impoverishment, for all the dung that is made on the place is used to feed the hops. Small patches of hops are very generally grown all over the Weald Clay area between Romney Marsh and Tonbridge, but the abandoned kilns seen everywhere are evidence that the acreage has been declining very rapidly. As a rule the gardens run small and only the coarser varieties are grown; the management is poor, but these little gardens are worked very cheaply and made to fall within the general routine of a small farm without any of the heavy special expenses for labour, manure, &c., which are necessary when hops are grown on a large scale. The small farmer, therefore, is not risking much, and most of the returns for the crop are profit, low as the prices which he realises may be.

Hop growing, however, is declining very rapidly on these unsuitable soils, and the shrinkage of acreage to which we have already called attention has occurred to a much greater extent in the Weald than elsewhere. Some fruit, chiefly apple orchards in grass, is to be seen in the Weald, but the trees do not grow well and many varieties are subject to canker and other diseases; the apples, though often of an excellent flavour, are small and poor in colour.

Where it begins at the edge of Romney Marsh the general level of the Weald Clay is about 150 feet, but it falls away gradually inland, since it really forms the very flat valley of the river Beult, and when this stream joins the Medway the general level of the plain is only about 50 feet above sea level. As the Medway valley is approched near Staplehurst and Marden the agriculture improves and some good hop gardens and fruit plantations may be seen. These, however, are generally situated on thin patches of alluvium belonging to the present or earlier

Medway valley, and these beyond the river, in Hadlow, Tonbridge, Leigh, and other parishes, assume considerable dimensions and are distinctly lighter and more suited to cultivation than the Weald Clay proper. In this district also, even where there is no distinct deposit of alluvium, the clay is apt to be lightened by some admixture of sand that is really of alluvial origin.

Beyond Tonbridge the Weald Clay continues up the valley of the Eden as far as the county boundary, westward of which it widens out, until south of Reigate it has a width of ten or twelve miles, very flat and featureless. A little further west the Lower Wealden Beds which form the core of the Weald cease to crop out and the Clay becomes a considerable expanse, extending about 15 miles west of Horsham and about 10 miles northward and southward before its boundaries of Lower Greensand are reached. This wide area is more undulating and is traversed by the head waters of the Arun and Adur; though it is wet cold land, mainly occupied by grass or wood, the soil is a little lighter and arable cultivation is somewhat more general than in the eastern part of the area. Cow-keeping and the sale of milk to the large towns forms the staple industry of this district: a certain amount of cattle breeding is done and sheep are taken in to keep on the poorer farms, but few sheep are bred. Apparently the former extension of the Lower Greensand over this area has left behind a certain amount of sand which has generally washed off the ridges, leaving the heaviest soils on the heights. In this western area the subsoil often shows distinct beds and drifts of sand, and the soils in consequence are no longer the extremely heavy clays which prevail in Kent. In the neighbourhood of Horsham the sandy beds become consolidated into sand-stone and assume the importance of a distinct geological sub-division. The Horsham stone is a thin bedded fissile sandstone which forms a small area of higher ground to the west of Horsham, a considerable proportion of the area being occupied by the grounds of Christ's Hospital School and Dunn Park. The stone was formerly in general use for roofing purposes, but is no longer worked and has been replaced by tiles, which are not only cheaper in themselves but, being lighter, involve a correspondingly cheaper construction of the roof. From Horsham the southern branch of the Weald Clay runs eastwards with a width of about four miles for about thirty miles, until it disappears beneath the alluvial deposits of Pevensey Level, which thus occupies the same relation to the southern branch of the Weald Clay as Romney Marsh does to the northern. About Billingshurst, where the country becomes flat again, the farming is rather better; dairying is increasing, and there is a fair amount of arable land growing wheat and mangolds, though a great deal of hay is still sold and sheep are taken in for the winter. East of the Ouse the Weald Clay is extremely poor and rents are very low, while some of the land is still in common and other portions have been enclosed comparatively recently.

Composition of the Weald Clay.—The soil of this low Wealden area generally forms a stiff soapy clay in which a few small ironstone concretions can be felt; in the subsoil it becomes a little

lighter in tint and then at a depth of three feet or so nearly always shows a mottled blue and yellow or blue and red appearance. Another very characteristic feature is that below the surface, sometimes at a depth of only 6 inches, sometimes at 18 inches down to 2 feet, there occurs a layer of shattery ironstone concretions of no great size, known as "crowstone gravel" or as "cat's-brains." Though the nodules do not unite to form an actual pan the layer is often so coherent that it has to be broken up by crowbars or a pick before deep-rooting plants like hops or fruit will grow satisfactorily.

All over the Weald the land is in want of drainage; and experience has shown that shallow drains, 2½ or 3 feet deep, act better than deeper drains at 4 feet, because it is only the rain water coming from the surface which has to be dealt with, not subsoil water rising from below. The land cracks very badly during droughts, especially where undrained and unimproved by lime.

The mechanical analyses show that about three types of Weald Clay soils can be recognised, differing in their heaviness but possessing several features in common. In East Kent the heaviest soils occur, though samples 97 and 98 from Lingfield just across the Surrey border are almost as finely textured. A little coarse sand is included, but both coarse and fine sand together only amount to between 10 and 15 per cent; the silt is about 20 per cent; the proportion of fine silt is higher still (this being a very characteristic feature of the Weald Clay soils); while the clay amounts to nearly 30 per cent in the soils and considerably more in the subsoils. The heaviest sample obtained from any formation in the three counties in subsoil No. 97 taken at Lingfield, in which there is nearly 49 per cent of clay and 19 per cent of fine silt, while all the coarser fractions taken together do not add to thirteen per cent. Of the two Lingfield soils, No. 97 was taken from the top of a ridge of *Paludina* limestone, and No. 98 from the valley below; there is very little difference between them, except in the greater heaviness of the subsoil on the ridge, where the soil had been washed away so as to bring the unmitigated clay of the bed rock nearer the surface.

The second group of soils, which were chiefly taken from places near the middle of the area, though two come from East Kent and one from West Surrey, are still heavy clays, but without the extreme strength of those previously described. There is very little coarse sand and little more than 10 per cent of fine sand; the silt, fine silt and clay each amount to more than 20 per cent, the magnitude of the fine silt fraction being again characteristic.

The soils of the third group are all taken from localities in the west, except one from between Hildenborough and Penshurst, Kent, where evidently a local streak of sandy rock had been found, for the soil and subsoil down to 19 inches showed large fragments of sandstone and only below that depth did the smooth yellow clay begin. The soils on the western part of the Weald Clay contain a coarser grade of particles; the coarse sand amounts to 10 per cent or more; the fine sand varies between

20 and 40 per cent; and the clay is only about 10 to 12 per cent, though as in the other Weald Clay soils the fine silt equals or exceeds the amount of clay. The origin of the sand in these soils is still a little doubtful. The rock itself does contain layers and drifts of sand, though to what extent could only be determined by a study of well-sections in the district. There must also be a good deal of travelled sand from the Lower Greensand, the high escarpment of which is at no great distance, and the rather irregular variations between soil and subsoil suggest that the soils contain a good deal of drift material and have been somewhat rearranged by weathering agencies. Soil No. 51 was taken close under the escarpment near to the junction of the sand, so that it may very probably belong to the Atherfield Clay; it fits, however, very well with the Weald Clays, allowing for the large proportion of sand that had washed down the slope.

These western Weald Clay soils are really nothing more than heavy loams and are quite suitable to arable cultivation; they are kept wet by the very impervious character of the heavier subsoil and by the general flatness of the land, which renders the natural drainage slow and increases the difficulties of artificial tile drainage. A sample (No. 232) from the Horsham Stone area agree very closely with the sample from the Clay at Billingshurst; it is a heavy sticky loam, but contains both coarse and fine sand.

From the chemical point of view the most striking feature in the Weald Clay soils is their deficiency in carbonate of lime; the subsoils rarely contain as much as one-tenth per cent, and where the soils contain more it may generally be put down to artificial treatment with chalk or lime. Even the Lingfield soil (No. 97), taken on a limestone ridge, only shows 0·2 per cent of carbonate of lime in the soil and 0·07 per cent in the subsoil. The magnesia is comparatively low, 0·2 to 0·6 per cent, which is rather surprising considering that the well waters in the Weald Clay area are often undrinkable through the abundance of magnesia salts. To provide a proper water supply is, indeed, one of the difficulties of residence in many parts of the Weald; the wells are undrinkable through their saline character, and the cottagers are often forced to rely on rain water or ponds. The sulphuric acid is also not abnormally high, varying from 0·05 to 0·07 per cent, though the well waters are heavily charged with sulphates. The alumina amounts as usual to about one third of the clay; the iron is rather low, from 3 to 5 per cent, and it is characteristic of the formation that much of the iron is always in the ferrous state. Manganese is comparatively abundant, as much as 0·17 per cent in one sample.

Manuring of the Weald Clay.—With the great heaviness and bad physical condition of these soils, the first step in making them either workable or fertile must be a good dressing of lime, to be renewed fairly frequently for some years afterwards. The value of lime in the Weald has always been recognised, however much the practice of applying it may have fallen into disuse of late years. If one may judge from the innumerable ponds which occur on every farm, almost on every field, in the

Weald between Woodchurch and the Medway, a great deal of marling must have been done at one time. Gervase Markham, writing in 1625 on the enrichment of the Weald of Kent, states: "Howsoever this weald be of itselfe unfruitfull and of a barren nature, yet so it hath pleased the providence of the Almighty to temper the same, that by the benefit of Margle or Marle (as it is commonly called) it may be made not only equell in fertility with the other grounds of the shire, as well for corne as grasse, but also superior to the more and greater part of the same." He concludes that marling must have been an ancient practice—"as by the innumerable marle pits digged and spent so many yeeres past, that trees of 200 or 300 yeeres old doe now grow upon them, it may most evidently appeare." From a later passage in which he speaks of pastures "well set with white clover" as one of the results of marling, Markham would seem to be referring to true marl containing carbonate of lime, and yet in our experience no such marls are to be found in the Weald Clay. Grey, white, or mottled bands occur which resemble the marls of the Midlands, but they always prove to be non-calcareous, just as Marshall saw marl being applied between Goudhurst and Marden and found it to be "an impure fuller's earth, without a particle of calcareous matter in its composition." It is hard to think that all the ponds in the Weald are due to the digging out of this worthless material for spreading on the land, but the only other possible explanation is that the pits yielded Fuller's Earth or the *Paludina* limestone. Occasionally fields still retain the name "Marl pit field."

True marl not being available, lime should be brought from the Chalk at the nearest point available, and by its means a wholesale improvement can rapidly be effected in the dryness, workability, and fertility of the soil. One of the latest examples on a large scale is afforded by the extensive liming operations on Sir John Hollam's estate at Dene Park near Tonbridge, where about 20 tons per acre of lime ashes were applied, resulting in a permanent increase in the cropping power and letting value of the land. Such large amounts of lime are, however, not necessary or even desirable; 2 tons per acre of stone lime or even half a ton per acre of ground lime evenly distributed by a machine, if regularly renewed every four or five years, will be even more effective.

Not only is the Weald Clay soil deficient in lime, but phosphoric acid is also present in very small quantities; many of the soils contain less than 0·1 per cent and the sub-soils as a rule contain only about half this amount, while the citric-acid-soluble phosphoric acid falls to a very low figure indeed. These indications point to basic slag as a valuable manure, and trial has shown that on both the grass and the arable land in the Weald no more profitable or even necessary fertiliser can be used. The pastures should receive about 10 cwt. per acre, and further dressings of 5 cwt. per acre should be given every fifth year. Potash is comparatively low considering how heavy the soils are; the citric acid soluble potash is low, especially when the magnitude of the total potash figures are taken into account. This again points to the need of lime in order to bring the potash into a more available form.

The manures required on the Weald Clay are practically confined to lime and basic slag. Superphosphate and the neutral natural phosphates are not so effective as basic slag; high grade manures are too expensive for such poor land; and if a nitrogenous top-dressing is required for the corn this should be nitrate of soda and not sulphate of ammonia. Kainit gives little if any return. The recommendations as to seed mixtures on the London Clay may be followed in the Weald.

12. The Lower Wealden Beds.

Distribution of the Lower Wealden.—The Lower Wealden or Hastings Beds, which form the central ridge or core of the anticlinal structure making up the Weald, give rise to an elevated tract of country known as the High Weald, which extends from near Horsham to the sea coast about Hastings. Geologically the Lower Wealden series is divided into the Ashdown Sand, the Wadhurst Clay, and the Tunbridge Wells Sand. The Ashdown Sand is chiefly developed in the highest part of the Weald, in Ashdown Forest itself on the ridge which stretches from West Hoathley to Rotherfield, and in the Battle ridge which runs from Uckfield to Winchelsea. The Wadhurst Clay occupies the lower slopes of the valleys from near Tunbridge Wells* to Wittersham and the valleys of the Rother and its tributaries. The Tunbridge Wells Sand, which in the west consists of the old forest of Worth, now St. Leonard's and Tilgate Forests, also gives rise to the country round Lindfield and Chailey, and a broad belt of high land round Tunbridge Wells, running eastwards thence to the sea. Other sub-formations, as the Grinstead and Fairlight Clays, have been differentiated, but with the paucity of fossil remains it is not easy to trace these divisions, because the whole series possesses a very similar lithological character. All over the High Weald one finds a soil of a very similar character, though it is light enough to be called a sand in some places and works as heavily as any clay in others. As will be seen later the sands are all so extremely fine grained that they become sticky and clay-like when wet, while the clays contain more fine sand and silt than true clay. Other features they have in common are the absence of any carbonate of lime, a green and yellow mottled colour a little below the surface, and a tendency to form loose concretionary ironstone gravel in the subsoil, so that the whole area can be regarded as occupied by one type of soil, which varies considerably from light to heavy forms within the type. It is characteristic of the Lower Wealden, and to a less degree of the Weald Clay soils, that they dry with a very white surface, often looking as light coloured as a chalk soil. This is due to the very fine sand and silt washing on to the surface of the clods.

Immediately to the east of Horsham the "Forest Ridge" begins and reaches a height of more than 400 feet in the wooded region there known as St. Leonard's Forest; the country gradu-

* The Clay on the hills at Tunbridge Wells, *e.g.*, Rusthall Common, is Weald Clay.

ally rises until at Handcross, where it is crossed by the Brighton Road, it is over 500 feet above sea level. At about this elevation it continues until near West Hoathley, where there are small areas above the 600 feet contour line. In this western part of the High Weald the soil is light and sandy, and the country is much cut into by deep gylls, or steep-sided ravines excavated by the small streams; there is comparatively little farming except in the valleys, the hillsides being chiefly clothed with woods—oak and ash below, chestnut, birch, and conifers on the higher ground.

East of the railway from East Grinstead to Horsted Keynes the High Weald is deeply scored by the valley of the Medway and its tributaries. The northern part of the area forms a stretch of diversified country, often steep though rarely reaching a much greater height than 400 feet, which extends from East Grinstead by Cowden and Tunbridge Wells to Cranbrook, and then turns more southward to the sea about Rye. In this area the greater part of the land is farmed, and some excellent soil exists in the bottoms of the valleys, but there is a good deal of woodland, especially of chestnut plantations for hop poles. East of Tunbridge Wells the rich and well managed hop gardens and fruit plantations, with the luxuriant meadows on the lower ground, are in strong contrast to the somewhat poor grass land on the tops of the hills. Even in this favoured area the high cultivation is reserved for the hops and fruit, otherwise there is not much arable land and the general farming is not of a very high order. Fig. 37 shows one of the cultivated valleys in the High Weald with the woodland on the crown of the hills.

Coming back to the west again, the Forest Ridge is continued to the south of the Medway from West Hoathley into Ashdown Forest, culminating in Crowborough Beacon, where an elevation of 792 feet is reached. Most of Ashdown Forest is open unenclosed heath, black and peaty in aspect, with some conifers on the heights and hard wood on the lower slopes. The soil is naturally poor and the country generally too elevated for farming; highly esteemed as it now is for residential purposes Cobbett expresses the farmer's opinion: "you cross Ashurst Forest, which is a heath, with here and there a few birch scrubs upon it, verily the most villainously ugly spot I ever saw in England. This lasts you for five miles, getting if possible uglier and uglier all the way till, at last, as if barren soil, nasty spewy gravel, heath, and even that stunted, were not enough, you see some rising spots, which instead of trees, present you with black, ragged, hideous rocks." . . . "From the end of this forest without trees you come into a country of but poorish wettish land." The Forest Ridge continues to Rotherfield and Wadhurst, to the south of which the Weald is deeply cut by the headwaters of the Rother on the one hand and of the Ouse on the other. South of the Rother Valley, however, another ridge begins, and from Hadlow Down through Heathfield (589 feet) and Brightling (647 feet) it continues at a height of 400 feet or so to Battle and the sea at Fairlight, east of Hastings. This Battle Ridge is heavily wooded, oak and chestnut being the predominant trees, the cultivated land being mostly poorish grass and the farming generally of a low order.

The High Weald is well provided with running water, but though the tributaries of the Ouse chiefly drain the southern side of the ridge the central mass is mainly cut by the tributaries of the Medway and the Rother into longitudinal valleys running east and west. Owing to the softness of the rocks these valleys are very steep sided, so that throughout the Weald the gradients are much more severe than the height of the hills would lead one to expect. Indeed, so thorough has been the erosion that along the course of the Rother and its tributaries the marshes at sea level penetrate many miles back into the hills along the courses of the rivers. Another consequence of the soft nature of the rocks is that the Sussex rivers rarely run clear; even in the driest of summers the water still carries fine material in suspension and is distinctly cloudy; never do the Sussex streams possess the limpidity and brilliance that characterise a chalk stream or a mountain burn. So soft are the sandstones in these lower Wealden Beds that they are rarely worth calling rock; in a few places, however, as near East Grinstead, a harder layer exists which is worth working as a fine-grained building stone, and more consolidated bands are found in the cliffs from Rye to St. Leonards, weathered boulders of which, gathered from the beach, are found in most of the older buildings in the district. Until within recent years, however, when granite and quartzite has been brought in from a distance, roadstone of any kind was rare and the roads notoriously bad. They were not only bad owing to lack of stone but because of the steep slopes and the very wet bottoms which had to be traversed; it should be noted how carefully the roads follow the ridges; seldom do they follow the river valleys, across which they cut as rarely as possible.

Despite the bad roads the High Weald had at one time a considerable industrial importance, not only for its iron trade, but also for the cloth-working that was carried on, chiefly in the Kentish towns. The iron workings in Sussex probably go back to the times when iron first began to be used: they certainly existed in Roman times, for coins, &c., have been found in the old slag heaps. The ore was obtained partly in concretions, partly in layers of spathic carbonate of iron from near the base of the Wadhurst Clay; the fuel was charcoal, and the industry began to decline as the supply of fuel became restricted and dear, because it was no longer able to compete with the method then newly devised in Durham of turning coal into coke fit for iron smelting. Up to the sixteenth and seventeenth centuries, however, Sussex was the great source of British iron, and though few of the cannon which were one of the most important products of the forges now survive, a good many articles of domestic use, particularly the ornamental fire backs, are still common within the district.

It is believed that the cloth trade was introduced by Flemish refugees from the religious persecutions, who doubtless settled in the Weald because of the supply of wool in the district, and also because of the fuller's earth which accounts for so many of the ponds in the Low Weald. The cloth trade was at its height in the sixteenth century, and, as the source of many fine old old houses in Cranbrook, Goudhurst,

Tenterden, and other small towns thereabouts, has left its mark; the trade gradually decayed, and had almost entirely disappeared when Hasted wrote his History (1790). No modern industries have grown up to take the place of the cloth or iron, but of the latter one small connection survives in the shape of charcoal burning, which is still practised by a few "colyers" in the great woods of the Weald. The charcoal finds a ready market among the hop growers, most of whom in Sussex dry their hops over fires burning chiefly charcoal. Very often the hop grower buys a few acres of underwood at one of the periodical fellings and employs the "colyer" to fell and burn it for him, and on many farms in the woodland area are to be seen the hearths on which the charcoal burner usually makes his pit.

Agriculture on the Lower Wealden.—Agriculturally the High Weald is but a poor country; the high land is occupied by heath or woodland, the lower slopes are mostly poor grass, and it is only in the valley bottoms, and then chiefly in the eastern Kentish part of the area, that any rich and highly cultivated land is to be seen. In general there is but little arable farming, and neither barley nor turnips are cultivated in any great quantity, but wheat and mangolds grow well enough. Stock raising on the grass land forms the mainstay of the farming; this country is the original home of the Sussex cattle, but less breeding is done than would be expected, the Sussex herds are almost all small and in few hands, and a good many Irish Shorthorns are brought in for fattening. Dairying is also very general, especially anywhere within reach of one of the railway lines, by which both the south coast watering places and London can be reached. The cattle usually kept for milk are of the Shorthorn type, but as Sussex bulls are mostly used and the calves are at once sold off to be grown on as beef cattle, but a poor lot of milch cows are to be seen in the district.

Sheep are very general and most of the smaller farmers take in sheep off the marshes for the winter months. As these sheep are rarely or never given any artificial food, even hay, and as it is generally stipulated that they should be put on land which has been previously mown for hay, so that it carries no taint of sheep, there need be little wonder that the grass land is reduced to a state of poverty. Indeed, the only good pasturage is on the river meadows or "brooks," which line the river courses far inland from the marshes into which they eventually merge. The rich farming of the High Weald is practically confined to the eastern portion, and particularly centres round the valley of the Teise, a tributary of the Medway which runs by Cranbrook, Lamberhurst, Goudhurst, and Horsemonden. In this district highly cultivated hop gardens, many of them famous for the heavy crop of Fuggles they regularly yield, alternate with fruit plantations, of which apples, black currants and nuts are the most flourishing. Outside this favoured district the hop gardens are small and scattered, though just behind Rye there is another small area in which they are or were comparatively numerous, for extensive grubbing has taken place of late years. Elsewhere in East Sussex the hops occur in isolated patches, generally at

the bottom of some small valley, where a greater depth of soil and the shelter of the woodlands on the heights above have combined to make the conditions favourable. Enormous crops are sometimes grown on these sheltered patches, but even so the acreage under hops in this district is shrinking fast; very few are now to be seen west of the South Eastern Railway to Hastings, though the abandoned oast houses tell of the former extension of the crop. A few plantations still exist in the Medway valley by Forest Row and Hartfield, but they are rapidly disappearing from this district, as they are also from the Rother valleys about Wadhurst and Ticehurst. Thus the agriculture of the High Weald bids fair to lose what was one of its most characteristic and profitable branches: the reason for this is not clear, because the hops grown there, though belonging to the coarser varieties, and naturally not so delicate in colour as the Mid-Kent and East Kent hops, can yet be of excellent quality and are very cheaply grown on the rich valley soils. Probably because the Weald growers are more scattered and isolated than the Kentish growers they have not kept pace with the improvements in cultivation and management which have become general elsewhere, hence for many years past they have been going out of the business. The tendency of hop growing has been to pass into the hands of specialists, who grow as many as their land and capital permits, but the Weald farms rarely lend themselves to any considerable acreage of hops, for which practically only the alluvial flats and the adjoining fields in the bottom of the valleys are rich enough.

The chief agricultural development which has been seen in this district of late years has been the growth of the poultry industry; not only has the cramming business become firmly established in the piece of high country about Heathfield, but all over the Weald the raising, as distinct from the fattening of poultry, has become general, and the grass fields are nowadays generally to be seen stocked with fowls.

Composition of the Lower Wealden Soils.—An examination of the mechanical analyses shows the essential similarity of the soils of this area: they are all practically devoid of the coarser fractions, though several contain 1 to 3 per cent of fine gravel, *e.g.*, No. 172, the heaviest of the series, in which the coarse material consists of concretionary ironstone and not of sand. As a rule the coarse sand does not amount to 1 per cent, and even the open heath at the top of Ashdown Forest near Wych Cross (No. 241) shows only 0·3 per cent of coarse sand in the surface soil, while only one soil from Greatham (No. 246) shows about 5 per cent of coarse sand. In consequence of this lack of the coarser fractions all these soils are close and stick when wet, even though they may become loose incoherent sands on drying.

The fine sand forms one of the largest fractions, constituting nearly half the soil in some cases and only falling below 20 per cent in one very heavy soil. The distribution of this fraction does not greatly depend on the geological horizon from which the soil has been derived, *e.g.*, the Ashdown sand at Wych Cross

contains 53 per cent, but a Tunbridge Wells soil from Groombridge contains 47 per cent, and a Wadhurst Clay from Ashurst contains 36 per cent, these being the three highest quantities found in the series. The silts are both well represented, the silt being as much as 35 per cent in some cases, while the fine silt is always over 10 per cent, and in several samples rises above 20 per cent.

The clay though variable is generally low, and in two soils from high up on the Forest Ridge it falls as low as 5 and 6 per cent, but in the majority of the soils it amounts to about 15 per cent, and only in one case (Ewhurst, No. 172) does it rise above 20 per cent. In itself, however, this amount would not be sufficient to account for the retentive heavy-working nature of this soil, which is due to the great deficiency in the coarser fractions, for the gravel, coarse and fine sand together do not add up to 20 per cent. Thus all these soils of the Hastings series are characterised by the predominance of fine sand and silt; coarse sand is lacking, and clay is only moderately represented. They all become in consequence close and sticky when wet, in which condition even the lighter soils appear clay-like to walk over, even though they dry into loose sands, while the heavier soils wash when the rainfall is at all violent, and afterwards show deposits of extremely fine sand in the furrows at the lower parts of the field. The heavier soils are by no means easy to cultivate; they must not be worked when wet, and even when dry enough to take the horses the lower part of the furrow slice generally turns up very sticky. The draught of ploughs and cultivators is extremely heavy, and even when a good seed bed has been obtained the soils run and set with a tough impermeable surface if heavy rain fallows. Some of the difficulty met with in working these soils may be set down to the fact that the finest fractions—the silt and the clay—consist rather of very fine sand than of true clay, as shown by the comparatively low percentages of alumina and potash. In consequence the clay does not flocculate readily.

Chemically all the soils are characterised by a lack of carbonate of lime; the Wadhurst Clays generally give off a little carbonic acid with acid, but this is probably derived in part from carbonate of iron, though the greater fertility of the Wadhurst Clay soils may be associated with the larger amount of base they usually contain. Many of the soils are actually acid; Spurrey, Sheep's Sorrel, and Corn Marigold are common weeds on the lighter land, and clubbing of turnips is general in the allotment gardens, though turnips are too rarely grown throughout the area to cause the disease to be much of a trouble to the farmer. Another indication of the lack of lime is the invariable presence of ferrous compounds in these soils.

The amount of phosphoric acid in the soils of the Hastings Beds is generally low, though the sands do not respond to phosphatic manuring as greatly as might be expected from the analyses; all the soils, however, and especially the heavier ones, are in need of phosphates. It is only the hop garden soils which have been receiving heavy manuring for many years that show

more than low percentages of available phosphoric acid. The most notable example of richness is soil No. 179 from Rolvenden: this contains 0·182 per cent of nitrogen, 0·082 per cent of available phosphoric acid, and 0·074 per cent of available potash. Potash also is never present in large amounts, and though the deficiency is in accordance with the comparatively low percentages of clay, it is not what would be expected from the heavy character of the soils. It has been found that on all these soils, especially on the lighter ones, crops respond to dressings of potash manures: gypsum, which is very commonly applied to hops in Sussex, owes its success to its power of rendering more available whatever potash may be in the soil. The waste heath soil from the Forest Ridge showed only 0·029 per cent of potash, but of this as much as 0·0167 was soluble in dilute citric acid: the high proportion available is due either to the acidity of the soil or to the potash being present mainly in the vegetable residues in the soil rather than in the mineral constituents.

Magnesia is not abundant in these soils, and in the sands either of the Tunbridge Wells or the Ashdown series it often falls below 0·1 per cent, and even in the heavy Wadhurst Clay soils it only reaches 0·3 per cent. The amount of lime is not much greater, but in all cases more lime than magnesia was found.

The alumina varies in amount with the clay but always forms a lower proportion of the clay than usual: the amount of iron is above the average, except in the lightest sands, ferrous iron being always present in the sands but not in the Wadhurst Clays. Of manganese there is only a trace, except in two cases, when 0·12 (Soils No. 242 and 244) and 0·13 per cent were found.

The sulphuric acid is a little below the normal, varying from 0·02 to 0·05 per cent.

Manuring of the Lower Wealden.—The land over the whole of the High Weald is very greatly in need of lime, and regular applications of lime in some form or other must form the foundation of any improvement in the fertility of the soil. On the heavier soils it is wanted both to provide the indispensable base and to improve the texture and working character of the land, while on the lighter soils it may even be necessary to correct actual acidity. Too much stress, however, cannot be laid upon the importance of liming both the grass and the arable land in this district. Unfortunately except for a narrow outcrop of Purbeck limestone at the very heart of the Weald near Mountfield and Brightling, there is no source of limestone within the area; lime has to be brought from some point in the ring of chalk which surrounds the Weald, *e.g.*, from Dorking or from Lewes. White lime should be bought, and as the lime-burning firms appear only to grind the grey lime, which is much inferior for agricultural purposes, it is better to buy the white lime in lumps, throw it out in small heaps on the arable land, and cover with a little soil for a few days until it has slaked and then scatter the heaps about as thoroughly as possible. It is better to use moderate amounts, 1 to 2 tons per acre, and renew the application every four or five years.

Most of the land is also in need of phosphatic manuring, and nothing is more suitable for this purpose than basic slag; the arable land should receive 4 or 5 cwt. per acre once during the rotation, for the bean crop for example. Hops will repay a much more frequent use of basic slag; indeed, this fertiliser ought to form part of the annual dressing for hops on all the heavier soils. As for the poor grass land of the High Weald, so greatly impoverished by the constant mowing and grazing with store steep, an enormous improvement can be effected by a dressing of 5 cwt. of basic slag, repeated after 4 or 5 years. Where the land is to be mowed regularly, 3 cwt. of kainit should also be given from time to time, and 1 cwt. or so of nitrate of soda, given in March each year before the land is laid up, will be repaid in the increased crop and general encouragement of the herbage. These High Weald grass lands, except in the lightest and most elevated parts of the country, are capable of great and remunerative improvement by careful manuring. Even on the rich grazing lands in the valleys, which have been heavily stocked for generations and have had large quantities of cake and corn consumed upon them, will be improved by an occasional dressing of basic slag; the benefit will not be seen in any change in the appearance of the pastures, which will, however, be found to carry more stock and fatten better.

The crops grown in the High Weald which are most likely to require manuring are beans and mangolds; for beans it is desirable to spare a dressing of dung, say 10 tons to the acre, and add 4 or 5 cwt. of basic slag, both to be ploughed in before the beans are sown. Mangolds should also receive dung, as much as can be spared, and about 3 cwt. per acre of kainit should be sown broadcast before the land is first worked in the spring, then 1 to 2 cwt. of a mixture of sulphate of ammonia and nitrate of soda together with an equal weight of salt should be used as a top dressing when the plants are singled. On these soils nitrate of soda has a bad name because of the injury to the tilth which follows its use.

Hops should receive 1 to 2 tons of shoddy and about 5 cwt. of basic slag, ploughed in before the winter, to be followed up in spring with 5 to 8 cwt. of fish or meat guano. Dung should be used occasionally in place of the shoddy, and on the lighter soils about 4 cwt. of kainit should be added to the winter dressing.

The most troublesome weeds on this formation are Spurrey (*Spergula arvensis,* L.) on some of the lighter soils, the Field Horsetail (*Equisetum arvense,* L.), Cud Weed (*Gnaphalium uliginosum,* L.), and Groundsel (*Senecio vulgaris,* L.), and some Knotgrass (*Polygonum aviculare,* L.). True Couch (*Triticum repens,* L.) is not common, but Bent Grass (*Agrostis alba,* L.) is generally given that name and is the worst weed of all to deal with, often forming a thick mat over the stubbles after harvest. On the old grass land the most striking feature in the spring is the abundance of Sweet Verñal (*Anthoxanthum odoratum,* Linn.).

Grass mixtures usually take very well on these soils; red clover and rye grass are chiefly used for one year leys, while for more

permanent grass land the mixtures specified on page 78 may be used. Lucerne is but rarely grown in the district, and if sown it should be inoculated beforehand with the appropriate nodule organisms. Even then it is not likely to be established at the first attempt.

At the very core of the Weald there occurs a narrow outcrop of Sub-Wealden rocks belonging to the Purbeck series just along the crest of the Battle Ridge from Heathfield eastwards. Agriculturally, they are of no importance, being almost wholly covered by woodland. They are, however, interesting as providing a source of gypsum for manurial purposes: the formation is mined at Mountfield for gypsum, and though the greater part is worked up for various plasters and cements a certain amount is sold finely ground for manure. The number of abandoned lime kilns along this small outcrop show how much more attention was formerly given to the important operation of liming.

CHAPTER IV.

The Relation of Soils to Crops.

From the data which have already been discussed under the various formations, it becomes possible to obtain a general idea of the constitution of the soil which is best suited to any particular crop. For example, it is found that fruit-growing is carried on successfully on soils derived from the Brick Earth, the Clay-with-Flints, the Thanet Sands, the Chalk, and the Lower Greensand, while other soils neighbouring these formations are either without fruit or yield very indifferent results. By bringing together the analyses of these soils upon which fruit is grown, we find that they present many features in common and possess a general resemblance, so that it becomes possible to specify the nature of a fruit soil, and to predict beforehand that any other soil is or is not suitable for fruit growing. The basis for such a classification must be the mechanical analysis of the soil, though some of the items in the chemical analysis may also have to be brought into the account, particularly the proportion of carbonate of lime. The mechanical analysis must also be interpreted in connection with the prevailing rainfall, but in the main it is the structure of the soil as revealed by the mechanical analysis which determines the adaptability of the soil to a given crop. After all, as has been said before, the mechanical analysis does no more than extend and give numerical precision to the practical man's judgment of a soil as a clay or loam, or sand, and it is upon his recognition of the way a soil will work that the farmer decides what crops will be most profitable upon his land.

Wheat Soils.

From an examination of the Map (Fig. 45) it will be seen that wheat is more generally distributed over the area than any other crop, except perhaps oats, thus indicating that wheat is adaptable to a greater variety of soils than barley, turnips, or the more special crops like hops and fruit.

In some areas there is but little wheat, *e.g.*, on the Bagshots in West Surrey and throughout the Weald, but these are the districts in which there is the smallest proportion of arable land, with the distribution of which the wheat is closely correlated.

Wheat is most extensively grown in the maritime district of Sussex, and again on the Chalk and Lower and Upper Greensand in West Sussex, while in Kent it is densest on the deep Chalk Loams, the less elevated beds of the Clay-with-Flints, and on the Thanet Sands in East Kent, *i.e.*, on the deeper soils that are underdrained by the Chalk formation.

Thirty years ago the wheat area was much larger, and in particular the London Clay in East and North Kent, in the Island of Sheppey, and along the seaboard generally, was cultivated for wheat, but since the great fall in prices the expenses

of cultivation have proved too great, and the land has been laid down to grass.

In Table II. is set out a series of analyses of the typical wheat soils found in the area under consideration, each analysis representing a soil on which wheat grows successfully at the present time. The lightest member of the series is a Thanet Sand from East Kent, on which large crops of wheat of very fine quality are grown—Rough Chaff, or "Old Hoary" as it is locally known, being a favourite variety, because in that dry climate it can generally be harvested in good condition. This soil, though evenly textured, would be often of too light a character for wheat, but the Thanet Sands in East Kent are well supplied with subsoil water, and crops on them rarely suffer from drought. Wheat, moreover, is a plant which grows best when it becomes somewhat hot and dry during the later months of its growth, its deeper rooting system renders it independent of rain at frequent intervals, and apparently the conditions it finds most favourable during the later stages of growth are dryness and heat in the atmosphere, with a cool moist soil about its roots. Second in the table comes an Upper Greensand soil of considerable local reputation, then a Brick Earth from the Sussex maritime district, two Clay-with-Flints (one from East Kent, and rather heavier one from Surrey), and a heavy loam over Chalk from East Kent. These may be regarded as pre-eminently the wheat soils of the district. The London Clay from Surrey and the alluvium from Romney Marsh are distinctly heavier soils, but both grow great crops of wheat. Finally are set out the analyses of a Weald Clay from Kent, which will grow fine crops but requires so much care in management that most of the land of this character is now in grass, and of a London Clay soil from Sheppey, once famous for wheat and beans, but too expensive to work under the plough of late years. As an example of a totally different type of soil is given the analysis of an alluvium derived from the Bagshot Sand near Weybridge; although so light in texture, the field from which this sample was taken grows wheat excellently, because it lies below river level and has permanent water at little more than two feet below the surface. This will serve to illustrate the fact that the association of wheat with a particular type of soil really depends upon the way the soil maintains the supply of water to the plant, and is therefore greatly affected by the climate or other external conditions which may cause variations in the amount of water in the soil.

The conception of wheat soil, then, which may be obtained by considering the group of analyses, must only be regarded as true for the south-east of England, with an average rainfall of about 30 inches distributed very evenly throughout the year; it would, indeed, serve well enough for all the wheat-growing districts of England, but it is unlikely that it represents the best type of soil under such very different climates as prevail in many extensive wheat-growing areas.

By taking an average of the seven most typical wheat soils in the table, the following mean figures are obtained:—

	Mean. Per cent.	Limits. Per cent.
Fine Gravel	1·5	0·4- 5·9
Coarse Sand	4·0	0·0-12·8
Fine Sand	24·4	14·7-31·1
Silt	22·9	11·3-35·5
Fine Silt	13·3	9·4-23·7
Clay	18·7	13·2-23·7

Such figures indicate a strong soil in which there is but little coarse sand or gravel to keep the land open, though the fine sand and silt, the most abundant fractions, permit both of drainage and the return of water from the subsoil by capillarity. The clay and fine silt are considerable in amount, though not excessive, and the figures would rather suggest that wheat likes as firm and tight a soil as is consistent with cultivation at a reasonable expense.

An examination of the chemical analyses of the various wheat soils does not reveal any connection between their chemical composition and their suitability for wheat; the crop cannot be associated with either an excess or deficiency of any particular constituent. Given the right physical type of soil with a suitable situation and rainfall, it will be the previous management and the manuring which the crop has received that determines the magnitude of the yield.

Table II. WHEAT SOILS.

Formation	Thanet Sand.	Upper Greensand.	Brick Earth.	Clay-with-Flints.
Locality ...	Chislet. 63.	Bentley. 84.	Oving. 211.	Loyterton. 180*a*.
Fine Gravel ...	1·2	5·9	0·9	1·1
Coarse Sand ...	5·2	4·8	1·3	1·0
Fine Sand ...	32·1	26·5	16·0	30·7
Silt	33·3	25·9	35·5	24·9
Fine Silt	7·4	12·9	13·3	9·4
Clay	11·9	13·2	15·9	18·7

Formation	Clay-with-Flints.	London Clay.	Alluvium.	Weald Clay.	London Clay.	Alluvium.
Locality ...	Coulsdon. 111.	Tolworth. 107.	Orgarswick. 143.	Woodchurch. 69.	Sheppey. * 67.	Weybridge. 189.
Fine Gravel ...	1·7	0·4	0·1	0·5	0·5	1·3
Coarse Sand ...	5·7	12·8	0·0	2·5	0·3	38·4
Fine Sand ...	26·5	25·5	31·1	14·7	17·6	39·9
Silt	20·5	11·3	18·1	24·2	13·4	5·6
Fine Silt	9·6	11·1	12·9	23·7	15·3	5·1
Clay	20·0	23·7	19·7	20·1	36·8	3·8

* This last analysis represents a soil on which good wheat used to be grown, but which has now been laid down to grass for many years.

Barley Soils.

As will be gathered from the analyses given in Table III., the soil best suited to barley is distinctly lighter than that appropriate to wheat; in the district under consideration the most favourite barley soils lie on the Lower Greensand (including Bargate and Sandgate), and on the lighter examples of that formation rather than on the rich loams of the Maidstone district. The latter soils would probably grow excellent barley were they not so valuable for fruit and hops that very little general farming is practised upon them. After the Lower Greensand the light loams derived from the Chalk are next in favour; the most distinctively barley-growing district in the south-east of England is the Isle of Thanet, and the sample from Minster (No. 61) is very typical of the soils of that region—soils which are from two to four feet deep before they reach the bare chalk. Another chalk-loam from Sutton by Dover (No. 66) contains much more clay than any other barley soil; it is, however, kept so open by the 20 per cent. or so of carbonate of lime which it contains that it behaves as a light free-working soil, in spite of its high proportion of clay. Barley of good quality is grown in the maritime region of Sussex, but more on the coombe than on the deeper Brick Earths at a lower level. The higher rainfall which prevails in this district necessitates a lighter soil for the production of first-class barley than is the case in East Kent. For the same reason little barley is grown on the Upper Greensand shelf below the downs in West Sussex, though crops of good quality may be seen growing on the Hythe Beds in this district. Despite the light character of the land, the comparatively heavy rainfall (over 30 inches) makes the farmers prefer oats to barley; but it should be remembered that in this district the land is always folded in preparation for this crop. In regard to barley, the question of the tilth on which the crop is grown bears very intimately on the nature of the soil best suited to the crop. In East Kent very fine barley is also grown on the Thanet Sand; two analyses are given (Nos. 678 and 63), both being soils highly valued for the purpose.

Taking the soils in order, the first (No. 124) is an extremely light soil from the Lower Greensand in West Surrey; the coarse and fine sand fractions so predominate and there is so little clay and fine silt to bind them, that a high wind in dry spring weather has been known to blow the sand away until the young plant in its turn was uprooted and blown into the hedge at the side of the field. The rainfall in the district is fairly high—over 30 inches—and it is of the utmost importance to get the barley sown early, and to keep the soil well rolled. On this soil barley is always grown after turnips or some other green crop has been folded off by sheep, which also receive some artificial food.

The second soil (No. 203) is taken from the same district, though it lies on a slightly different geological formation; as in the first example more than half of the soil consists of coarse

sand and the fine sand also is above 20 per cent, while the clay and fine silt are both rather higher than before, though together they do not amount to 20 per cent. Here again the barley must be sown early, and it is always grown after a crop that has been folded on the land.

The next two soils (Nos. 678 and 122), though from widely separated geological formations, are almost identical in structure; the fine sand is now the predominant fraction, in each the clay remains at about 10 per cent, but the silt has considerably increased. These are examples of well balanced soils of a light, loamy character, allowing the rain to drain away rapidly, but which are sufficiently fine-grained to bring water back to the surface and keep the crop growing during the drought. These soils are best suited to grow barley after roots folded off.

The Chislet soil (No. 63), which comes next, is rather a stronger soil with less coarse sand and more clay; it also is a very well-balanced soil, lifting water steadily in a drought, and suited to grow barley after folded roots. It should be noticed that this is the lightest soil recorded as growing wheat successfully.

Soil No. 207 comes from the maritime district of Sussex; though it has only 13 per cent of clay, the coarse sand is almost absent, and the silts are both over 20 per cent. As this soil is generally also kept in high condition, better barley is obtained by growing it as a second white straw crop after wheat or oats than by taking it after roots.

Soil No. 61 from the Isle of Thanet, though it contains 16 per cent of clay, contains also about 10 per cent of coarse sand, and nearly 40 per cent of fine sand; as it is also taken from a district of exceptionally low rainfall, the soil is not too heavy to grow barley after folded roots, though it is also possible, and indeed customary, to grow two or three barley crops in succession on this land.

The three remaining soils are better suited to grow barley after a stubble than after roots; indeed, sheep cannot always be folded on these soils, especially not on 180a, which works more heavily than either of the other two because it contains no notable amount of either coarse sand or carbonate of lime to keep it open. Nevertheless, in the dry climate of East Kent it grows heavy crops of fine quality when the barley can be sown early after a crop of wheat.

There is nothing in the chemical analyses of these soils to call for comment or to suggest any significant correlations between the barley crop and the chemical composition of the soils.

In general it is clear that a barley soil should contain about 10 per cent of coarse sand to keep it open, and not more than about 16 per cent of clay. The greater part of the soil should be made up of the middle fractions, and the fine sand should probably be the largest fraction of all.

Table III. Barley Soils.

Formation	Lower Greensand.	Lower Greensand.	Thanet Sand.	Lower Greensand.	Thanet Sand.
Locality ...	Shalford. 124.	Eashing. 203.	Goldstone. 678.	Repton. 122.	Chislet. 63.
Fine Gravel ...	2·5	1·1	0·2	2·5	1·2
Coarse Sand ...	52·6	50·0	15·3	13·9	5·2
Fine Sand ...	26·2	20·2	44·9	44·6	32·1
Silt	4·8	6·7	17·3	14·1	33·3
Fine Silt	3·5	6·6	6·3	6·6	7·4
Clay	3·8	9·7	8·9	9·5	11·9

Formation	Brick Earth.	Chalk.	Lower Greensand.	Clay-with-Flints.	Chalk. *
Locality ...	Shopwyke. 207.	Minster. 61.	Aldington. 149.	Loyterton. 180a.	Sutton by Dover. 66.
Fine Gravel ...	0·6	0·6	0·9	1·1	0·5
Coarse Sand ...	0·8	8·8	16·8	1·0	1·5
Fine Sand ...	25·0	35·2	28·7	30·7	13·9
Silt	27·3	25·5	9·5	24·9	21·0
Fine Silt	16·4	6·7	9·5	9·4	6·4
Clay	11·1	14·6	18·8	18·7	23·5

* Though this soil contains a rather high proportion of clay for barley, it is kept open and easy-working by the large amount of carbonate of lime that is present—as much 20·3 per cent.

Hop Soils.

As shown on the map (Fig. 50), hops form one of the most localised crops in our area, being grown very thickly in one or two districts, but being entirely absent from the greater part of the three counties. At one time they were much more widely grown, but the shrinkage into particular areas has been going on with increasing rapidity of recent years, and has not yet ended. To a certain extent the presence or absence of hops is not entirely determined by soil; for example, the Farnham district in West Surrey possesses soil and climate entirely suitable to the growth of the best hops, yet the production there is rapidly declining, while there are many soils in West Sussex capable of growing excellent hops, though the crop has never been much grown in that region, and has now entirely disappeared. The tendency nowadays is to confine hop-growing to the best soils only, and to increase the acreage in certain districts at the expense of others more remote; hop-growing has become such a highly specialised industry that the grower in a comparatively isolated district falls behind in his methods when he can no longer learn from the innovations and experience of his neighbours. Thus the acreage under hops is shrinking fast in the High Weald, where the bulk of the land is of poor quality and the richer land in the valley bottoms rarely forms a very extensive area; on the Weald Clay

also the cultivation of hops is rapidly declining because of the unsuitability of the soil; and on the Thanet Sands hops are being replaced by fruit, which has proved more profitable on these lighter soils.

At the present time the chief hop-growing area lies on either side of the Medway valley between Maidstone and Tonbridge—the Mid-Kent country—and here the soils consist of deep loams resting on the Kentish Rag or alluvial loams of very similar character in the valleys of the Medway and its tributaries, underlaid in the district between Yalding and Tonbridge by the Weald Clay. This Mid-Kent district is prolonged into the Weald chiefly in the valleys formed by the Teise, and the hop-gardens are either on the alluvial soils in these valleys or on the deeper soils resting on the slopes of the Wealden Hills. As in Mid-Kent the hops occupy the lower land, which is too subject to late spring frosts to be suitable for fruit, but all the soils in the Weald are of a heavier type than those occupied by hops in Mid-Kent. In East Kent, where hops are again very extensively grown along a belt running roughly from Rochester to Canterbury and thence to Sandwich, the soils are more varied in their origin. The more loamy beds of the Thanet are used, though fruit is replacing hops on such soils, and also the deeper loams on the Chalk, including the deposits of Clay-with-Flints when they run down to a sufficiently low elevation, but the most valued soils of all are perhaps the Brick Earths, which form an ideal soil for hops when of sufficient depth. The soils of the Marshes in East Kent and Sussex have proved unsuitable for hops, which there grow far too rankly and yield produce of indifferent quality (*see also* p. 31).

Different varieties of hops are associated with the different soils prevailing in each district. East Kent is the proper home of the true Golding, both the Old Golding and the Canterbury Whitebine or Petham Golding are best suited by the comparatively dry soils and climate of that district; elsewhere it is apt to grow too rankly and to fruit indifferently. Associated with the Goldings in East Kent are always the Bramlings, which, however, are very generally grown on all soils, and the Cobbs' hop, which are always sold as Goldings. Fuggles do not answer well on the dry soils of East Kent, and though many other varieties are grown to some extent, none have any wide extension. In Mid-Kent the most favoured varieties are Bramlings, Cobbs, some forms of the true Golding, and a good many Fuggles. On the Weald and the Sussex soils the Fuggle is the characteristic hop; Cobbs are also largely grown, and Bramlings to a certain extent on the better soils; occasionally Mathons among the finer hops, and some of the coarser varieties like Prolifics. The Fuggle is essentially a hop for strong soils; Cobbs, though originating in East Kent, where they are still largely grown, also like the stronger soils, while Bramlings will answer on all types of land except perhaps the heaviest.

In Table IV. have been collected together the analyses of various soils on which hops are now being grown successfully, and it will be observed that, with exceptions at the lighter and heavier ends of the table, the good hop soils constitute a very similar and well defined type, from whatever formation they

happen to originate. The lightest example is a soil on the Thanet Sand from Newington, which shows about 80 per cent of sand particles and only about 10 per cent of clay and fine silt together. Such a soil is more fitted for fruit than for hops, and though there are several very successful hop-gardens upon this soil it is only effective because most of these Thanet Sand soils are exceptionally well supplied with ground water, and because in this particular case the proximity of the railway line enables very large quantities of London dung to be applied. The next soil, an alluvial soil from the neighbourhood of Yalding, probably consists of wash from the Lower Greensand hills (compare the East Farleigh soil No. 127), and belongs to a much heavier type; the sand constitutes less than 60 per cent of the soil, while the clay and fine silt fractions have risen to 20 per cent. Then follows a series of five soils, from the Thanet Sand, the Brick Earth, the Lower Greensand, and the Clay-with-Flints, which resemble one another very closely. Their mean composition is as follows:—

	Mean. Per cent.	Limits. Per cent.
Fine Gravel	0·8	0·3- 2·3
Coarse Sand	3·1	0·7- 9·5
Fine Sand	32·6	24·7-39·1
Silt	31·2	19·7-44·8
Fine Silt	8·6	6·3-11·1
Clay	12·8	11·5-14·7
	89·1	

From this table it is clear that the most pronounced features in the soils are the silt and fine sand fractions, which together account for more than 70 per cent of the whole; the fine silt and the clay make up more than 20 per cent, while the coarser fractions are only slightly represented. Thus the best hop soils are close and fine-grained, though the bulk of the particles are of sufficient magnitude to permit of the easy passage of water. This ensures a well drained soil, though one not subject to very rapid changes in water content and temperature.

The Upper Greensand soil which follows the five thus viewed collectively belongs to another and a slightly heavier type, containing a little more fine silt, though on the other hand there is more coarse material to keep the soil open. The succeeding soils, however, begin to be really heavy; that from the Hastings Beds at Rolvenden, though not particularly rich in clay, yet contains a high proportion of fine silt and only a trace of the coarser fractions; it forms a distinctly heavy and tenacious soil to work. Upon this soil are situated some very fine hop gardens yielding heavy crops of Fuggles, Cobbs, and similar hops. The land is, however, unsuited to Goldings, and the hops it does grow have a characteristic "coarse" appearance compared with hops from the soils of East and Mid-Kent. The last two soils are both from the Weald; one lies on the Weald Clay, and the other, of very similar composition, on the Wadhurst Clay, and both are really unsuitable for hops, though with skilful cultivation very heavy crops of the coarser varieties can be grown on the latter soil.

From the chemical point of view the analyses of the hop soils present no common features, except an extreme richness when they have been carrying hops for any length of time, because the annual additions of plant food in manure are far beyond the amounts removed in the crop. This excess and even waste cannot be avoided when the object is to screw up the production to the highest possible limit consistent with the health of the crop. The hop plant shows no very specific response to the individual constituents of plant food, *i.e.*, it has no special need for lime or for potash or phosphoric acid. It requires an all-round manure, and any excess or deficiency of a particular constituent should be determined by the soil rather than the plant. The mineral constituents have usually been somewhat neglected in manuring hops, and an excess of nitrogen has been employed, because the response of the plant to nitrogen is so visible in the foliage; in consequence, many of the older and richer hop gardens are seriously in need of lime and phosphoric acid. Potash is rarely of much service to hops, and only on the lighter soils of the Thanet and Hastings Sands, or the true Chalk loams of no great depth, is the use of potash salts effective.

Thus the richness of hop-garden soils is generally due to the manuring, but if success is to be attained, the foundation should be laid on a soil of the right mechanical structure, and even that will be of little avail unless the soil is also both deep and properly drained, preferably by the natural advantages of its subsoil and situation.

Table IV. Hop Soils.

Formation ...	Thanet Sand.	Alluvial.	Thanet Sand.	Brick Earth.	Hythe Beds.
Locality ...	Newington. 193.	Yalding. 140.	Barton. 118.	Teynham. 133.	East Farleigh. 127.
Fine Gravel ...	0·5	3·2	0·3	0·7	2·3
Coarse Sand ...	16·9	13·1	2·3	2·1	9·5
Fine Sand ...	57·3	40·0	34·7	39·1	30·6
Silt	8·2	16·5	36·2	26·1	19·7
Fine Silt	3·9	9·0	6·3	8·6	11·1
Clay	6·0	9·1	11·5	11·7	13·3

Formation	Clay-with-Flints.	Brick Earth.	Upper Greensand.	Hastings Beds.	Weald Clay.	Hastings Beds.
Locality ...	Loyterton. 180*b*.	Ickham. 129.	Bentley. 84.	Rolvenden. * 179.	Woodchurch. * 69.	Ewhurst. * 172.
Fine Gravel ...	0·6	0·3	5·9	0·4	0·5	2·9
Coarse Sand ...	0·8	0·7	4·8	0·5	2·5	1·8
Fine Sand ...	33·7	24·7	26·5	24·7	14·7	13·2
Silt	29·3	44·8	25·9	30·1	24·2	20·4
Fine Silt	8·5	8·6	12·9	19·7	23·7	22·4
Clay	13·0	14·7	13·2	14·9	20·1	25·1

* These soils only grow successfully the coarser varieties of hops.

Fruit Soils.

The distribution of fruit is in many respects similar to that of hops, except that a little fruit is grown over the whole area, and that the Thanet Sands and Chalk Loams in North West Kent are now heavily stocked with fruit but carry very few hops. In a contrary sense the fruit does not follow the Medway tributaries so deeply into the Weald. The explanation lies in the fact that on the whole fruit demands a warmer, lighter, and more freely working soil than hops do. In consequence some of the best loams, like those on the Kentish Rag or the Brick Earth, will grow good fruit or hops indifferently, but there are many soils just too light for hops but good for fruit, while at the other end of the scale soils may be found which grow hops fairly but are too heavy for most kinds of fruit (*see also* p. 35). For the different kinds of fruit also there is a certain range in the soils that are desirable; strawberries answer best on a light soil and are chiefly grown on the light chalk loams and the more sandy beds of the Lower Eocene in North West Kent, to a certain extent again on the Bagshot Beds in West Surrey, and on the Oldhaven and other sandy beds in East Kent. Raspberries and red currants also prefer a light soil, but gooseberries, plums, and apples, the mainstay of the fruit grower, require an ordinary free-working loam possessing some consistency. On heavy loams apples and black currants will still continue to flourish, but on anything approaching a clay many varieties of apple begin to canker, and all are slow of growth and yield comparatively small-sized fruit. Cherries also are somewhat particular in their soil requirements; not only must they have a deep loam like the Brick Earths or the less elevated beds of Clay-with-Flints in East Kent, but the soil should be distinctly calcareous, with preferably the Chalk itself at no great distance below. A dry climate is also essential; if much rain falls as the fruit is ripening the cherries crack and become unsaleable.

It is difficult to understand why the cultivation of hops and fruit on an extensive scale should have been so closely confined to East and Mid-Kent, when the many other suitable soils remain unplanted. Intercourse with Flanders doubtless gave the original start, and the growers in these favoured districts have stimulated one another to maintain their superiority. Of course the East and Mid-Kent soils are of the very best for fruit growing, and the dry climate results in a highly-coloured and well-ripened product; at the same time the trees do not make an excess of wood, but comparatively early reach a state of equilibrium when fruiting checks the excess of growth and obviates the necessity of pruning. Kentish as compared with west country orchards are certainly characterised by a lesser growth of wood and an earlier and fuller development of fruiting spurs.

Of the fruit soils, the analyses of which are set out in Table V., the first should hardly be regarded as a fruit soil, since it is taken

from the Bagshot Sands in Surrey and is more typical of the soil upon which so many nursery grounds are situated. It is suitable for raising young stock and not for growing fruit; cuttings and young seedlings develop roots very freely in this gritty well aerated soil, and also grow rapidly for a few years. There is a little strawberry growing on these soils, but the plants require very good treatment and frequent renewing.

The second soil, from the Swanley district, is also very light and more suited to strawberries, raspberries, and market gardening than to the growth of ordinary mixed fruit, but then comes a series of five soils, all of which are very similar in type and grow the finest of out-door fruit. They possess from 12 to 16 per cent of clay, with about two-thirds as much of the fine silt fraction, while the silt and fine sand fractions make up about 70 per cent of the whole, the coarser sand and gravel being but sparingly represented.

The mean of the analyses of these five soils shows the following figures:—

	Mean. Per cent.	Limits. Per cent.
Fine Gravel	1·0	0·3- 2·3
Coarse Sand	5·0	0·8- 9·5
Fine Sand	37·0	30·2-55·2
Silt	25·7	13·1-43·7
Fine Silt	8·3	5·7-11·1
Clay	12·7	10·4-14·6

This typical analysis is to all intents and purposes identical with the similar mean analysis for hop soils, though only one soil is included in both series; it should, however, be borne in mind that only the heavier fruit soils carrying apples, plums, cherries and the like are represented in the table, to the exclusion of still heavier soils which are of very little use for fruit though they will grow good hops. For example, the Hastings Beds at Rolvenden, which grow fine crops of hops, are unsatisfactory for many sorts of apples, though they will still grow excellent black currants, while the Weald Clay soil at the end of the table only shows stunted and cankered apple plantations.

For many kinds of fruit the chemical composition of the soil becomes of very great importance, much more so than for the majority of crops; cherries and other stone fruit are very dependent on a fair supply of lime in the soil, and, to be successful, plums require a good deal of potash. On heavy calcareous soils such as the Chalk Marl all fruit trees seem to suffer, and are liable to become "chloritic," the leaves turning white and dropping prematurely. With fruit, too, more than with any other crop, situation, aspect, and drainage, are all important; however excellently tempered the soil may be, success is not likely to attend the cultivator unless these factors be favourable.

Table V. Fruit Soils.

Formation	Bagshot Sand.	Thanet Sands.	Thanet Sands.	Brick Earth.
Locality	Wisley. 88.	Swanley. 181.	Selling. 81.	Wickham. 120.
	Only nursery stock.	Straw-berries.	Mixed Fruit.	Mixed Fruit.
Fine Gravel ...	0 1	1·2	0·6	0·3
Coarse Sand ...	17·1	10·2	4·7	0·8
Fine Sand ...	66·4	58·6	55·2	30·2
Silt	3·5	13·3	14·1	43·7
Fine Silt	3.9	5·1	5·7	7·8
Clay	3·6	5·5	10·9	10·4

Formation	Hythe Beds.	Chalk.	Clay-with-Flints.	Hastings Beds.	Weald Clay.
Locality	East Farleigh. 127.	Minster. 61.	Molash. 137.	Rolvenden. 179.	Sutton Valence. 43.
	Mixed Fruit.	Mixed Fruit.	Cherries. Apples.	Apples, Black currants.	Apples, bad.*
Fine Gravel ...	2·3	0·6	1·2	0·4	2·0
Coarse Sand ...	9·5	8·8	1·4	0·5	3·6
Fine Sand ...	30 6	35·2	34·0	24·7	10·6
Silt	19·7	25·5	25·4	30·1	12·8
Fine Silt	11·1	6·7	10 2	19·7	22·0
Clay	13·3	14·6	14·4	14·9	33·8

* This soil is too heavy for fruit, though apple orchards are found upon it.

Potato Soils.

Potatoes form another crop, the distribution of which is very localised and largely determined by the character of the soil. An examination of the map (Fig. 46) shows that the chief potato-growing area in the three counties lies in the north-west corner of Kent, not very far from London. This is a district of very varied soils, but the potatoes are almost entirely grown upon the Thanet Sands, which are very light and sandy in that district, and upon the light loams resting upon the Chalk. In Surrey also, close to the metropolitan area, a good area is planted with potatoes, either upon the light alluvial soils, the chalk loams, or the thin patches of Bagshot Sand which cap some of the higher

ground in this district. Intensive potato growing may even be seen upon the London Clay in this neighbourhood, this being only rendered possible by the cheapness and availability of large amounts of London dung. Potato growing extends into Surrey along the belt of loams resting upon the Chalk, but it does not form a prominent crop upon the Bagshot Sands, where other forms of market gardening are common. Further south there is a certain amount of potato growing along the line of the Lower Greensand, both in Surrey and in Kent west of Maidstone, but in Sussex potatoes are rarely cultivated on a farming scale except for local supply in the neighbourhood of Worthing and Brighton.

Table VI. sets out a series of analyses of soils upon which potatoes are regularly grown for market; it shows that they are chiefly derived from the Thanet and Bagshot Sands, the Lower Greensand, and the Chalk, the one exception being a London Clay soil not very far from London. Leaving this particular case out of consideration all the other soils possess a marked similarity; they are light and contain but little clay or fine silt, but their most distinctive characteristic is the predominance of fine sand, which is much the most abundant fraction in all cases save one.

Taking a mean of the analyses the following figures are obtained:—

	Mean. Per cent.	Limits. Per cent.
Fine Gravel	0·9	0·1- 2·9
Coarse Sand	20·6	2·0-46·6
Fine Sand	45·2	22·9-68·1
Silt	10·8	3·5-21·4
Fine Silt	6·0	4·8- 8·8
Clay	9·0	5·5-12·6

This forms much the lightest type of soil associated with any crop in the area considered; even the London Clay soil at the end of the table, which has already been noted as exceptional and only cropped with potatoes because of the large quantities of London dung available, is much lighter than the majority of London Clay soils, and probably contains some admixture from the Bagshot Beds or the sandy layers near the top of the London Clay formation.

Table VI. Potato Soils.

Formation ..	Thanet.	Lower Greensand.	Bagshot.	Thanet.	Bagshot.	Thanet.	Chalk.	London Clay.
Locality	Swanley. 181.	Nutfield. 102.	Bisley. 90.	Teynham. 61.	Claygate. 104.	Greenhythe. 650.	Minster. 62.	Chessington. 105.
Fine Gravel...	1·2	2·9	0·1	0·5	0·7	0·3	0·5	0·6
Coarse Sand...	10·2	46·6	29·5	15·0	24·8	2·0	16·0	16·9
Fine Sand ...	28·6	22·9	47·5	48·9	38·6	68·1	31·8	31·2
Silt	13·3	3·5	5·3	15·2	11·2	2·6	21·4	14·7
Fine Silt ...	5·1	8·8	5·8	5·4	6·2	4·8	5·9	8·8
Clay	5·5	6·9	7·1	9·3	9·9	11·6	12·6	14·9

Commons and Wastes.

The prevalence of commons and open unenclosed land is a marked feature of the south-east of England and particularly of the County of Surrey, which, indeed, owes much of its charm and its attractiveness for residential purposes to its large areas of waste that must remain unbuilt upon.

Unfortunately, it does not appear to be possible to obtain any exact statistics of the extent or the distribution of the common land, the legal and the popular definitions of a common do not always coincide, and records only appear to be kept at the Board of Agriculture of particular classes of commons existing under special forms of tenure. Nor does the return of "heath and mountain land used for grazing" afford any assistance; in fact, a return of the open land over which the public (whether with right or not) wanders at will could only be compiled by a careful study of the Ordnance maps and some personal acquaintance with each parish. Without claiming any such minute knowledge, the authors consider it may be of interest to follow a little the distribution of common and waste land in the three counties, and ascertain how far such distribution may be correlated with the geology and the soils.

Taking the formations in their geological order very little unenclosed land is to be found on the true alluvial soils or on any of the recent deposits. In the neighbourhood of London only and along the Thames Valley do we find several commons on the light valley gravels and sands (often washings from the Bagshot Beds) which there prevail. Such are Mitcham and Barnes Commons, Putney Heath, Kingston Park and Ham Common, Esher Common, and a few others along the course of the river. Taking the Clay-with-Flints as the next older formation, in East Kent there are several uncultivated areas on this formation, "minnises" or "lees" as they are there known, but little else of the kind is to be found until Walton Heath and Headley Common on the top of the Downs above Reigate are reached.

On the Bagshot Sands lie, perhaps, the greatest number of the Surrey commons; beginning with Wimbledon Common there is an almost continuous line of commons as far as the Hampshire border—Oxshott, Ockham, Wisley, Horsell, Whitemoor and Pirbright Commons all belong to this formation. Even when not technically common, great areas on the Bagshot Sands are still open unenclosed wastes, much of which, as at Bisley, Pirbright, the neighbourhood of Aldershot, &c., has become the property of the War Office.

On the adjoining London Clay there are but few commons, though Epsom, Ashtead, Clandon, and Horsley all have some common land on this formation.

The upper pebbly beds of the Lower Eocene—the Oldhaven on Woolwich Beds, give rise to many commons to the south-east of London; examples being Dartford and Bexley Heaths, Hayes and Wickham Commons, the commons of Woolwich and Blackheath, and other open areas in that district. Further east the

Lower Eocene Beds are more loamy and have always been too valuable to be left unenclosed.

On the Chalk proper, as distinct from the Clay-with-Flints, commons are rarely or never seen, even village greens are rare and small. Great areas of unenclosed downland occur on this formation; the steep escarpment of either the North or South Downs is generally unenclosed, though in many cases it is not so much open grass land as diversified scrub of gorse, juniper, and the many flowering bushes which grow so characteristically on the Chalk. In Kent there are but few true down sheep walks, Barham Downs, south of Canterbury, being one of them; in Surrey, however, there is a good deal of open land still unbuilt over, the Epsom and the Fetcham Downs being examples. In Sussex, as it has been repeatedly stated, the high Chalk country is all unenclosed from the valley of the Arun eastwards.

The Upper Greensand and the Gault possess no commons, but on the upper sandy stratum of the Lower Greensand the Folkestone Beds—a string of commons occurs throughout the three counties. In East Kent we find Brabourne and Willesborough Lees, Hothfield Common, Charing and Lenham Heaths among others, and though in Mid-Kent they are not so common (Cox Heath has been enclosed within comparatively recent times), open land is again a characteristic, not only of the Folkestone Beds, but of the whole series of Lower Greensand from Sevenoaks eastward to the Hampshire boundary and round the southern extension of this formation as far as the valley of the Arun. Limpsfield and Crockham Hill Commons, Reigate Heath, Coldharbour and Wotton Commons, Blackheath and Farley Heath all lie east of the Wey, west of which comes a very extensive area of unenclosed land, in which the best known areas are Hindhead, Blackdown, and Woolmer Forests, while Puttenham, Farnham, Tilford, Newsham, Kingsley, and Bramshott possess definite commons. Further south come Rake, Rogate, and Westheath Commons (the latter on the Sandgate Beds), and the line is continued by Henley and Graffham Commons until west of the Arun the Greensand loses its elevation. East of Midhurst the waste is to be found on the Folkestone Beds, which lie to the south of the river Rother, the Sandgate and Hythe Beds being mostly under cultivation. A great part of this Lower Greensand is, however, not technically common land, and is being steadily enclosed; it falls within our purview as heath and waste that has never been cultivated. On the Weald Clay but few commons are to be found in Kent, but in West Surrey, and again on the southern arm of the Weald Clay in Sussex, nearly every village possesses a common or a large green. So numerous are these unenclosed areas that it would be tedious to enumerate them; many of them are still private property and subject to enclosure, indeed, many enclosures have been made within the last hundred years. The High Weald naturally contains a large proportion of unenclosed land; much of the old forests of Ashdown and Worth never carried trees but was open heath, with timber in the bottoms and gylls, particularly in the west (Worth, Tilgate and St. Leonard's

Forest) the enclosures and plantations are of comparatively modern origin. Unenclosed land is now chiefly to be seen about Selsfield Common, which is part of the Forest of Worth, in the neighbourhood of Tunbridge Wells, and the great heaths of Ashdown Forest in the neighbourhood of Crowborough. Further east and along the Battle Ridge, though there are many greens and small wastes, there are few large areas of true common.

From this review it will be seen that the commonland nearly all occurs on the lightest sandy formations, particularly when they run up to any elevation above sea level. The Bagshot Beds and some of the alluvial deposits derived from them, the pebbly beds of the Lower Eocene, the Folkestone Sands, and the coarse sands of the Hythe Beds in the west, then the sandy beds of the Lower Wealden series, possess by far the greater part of the unenclosed land. In all these cases the soil has been too light and open and too devoid of carbonate of lime to have been worth bringing under cultivation. Before such land can be made fertile or even remunerative it must be chalked and clayed, and even then it is often so exposed and elevated that it would remain of little value. At the other end of the scale there occur a few commons and wastes on the London and Weald Clays, where the soil is very heavy and wet. There is much less common on this type of land, because however expensive to work it would produce crops of wheat and beans at times when corn prices were high, and, consequently, it has always been more subject to enclosure. The open chalk downs belong to another category; in their case the soil is very thin and dry, the distances from the homesteads are generally great, so that they have largely remained out of cultivation, though great areas were broken up during the Napoleonic wars. They have, however, always been of much value for sheep, and on the South Downs in particular have always been an essential feature in the system carried on in those districts. The commons and wastes are thus almost always on soils that are too light to be profitable under cultivation, especially are they too light for wheat and beans, formerly the most profitable of crops. Elevation is also always a factor, light land above 3-400 feet generally has remained heath and waste, whereas the stronger soils at that height are planted with wood if they do not carry pasture. On the free-working loams which are normally under the plough, practically no common land exists; the opportunity of enclosing such land was always taken at an early date.

Finally, a few commons occur on the heavy clays; great elevation or some accident of proprietorship has alone kept these unenclosed or unplanted with timber. The temptation to enclose has always been much greater for heavy than for light soils in the days before the introduction of fertilisers, because the former would long continue to yield some sort of a crop if cultivated.

In Table VII. a number of analyses of common and heath soils have been brought together; the first and largest group are characterised by the abundance of coarse sand and the lack

of the finer silt and clay fractions, accompanied by a great lack of soluble mineral matter and of carbonate of lime. Soils of so light a type are but rarely found in cultivation, except in the neighbourhood of large towns where great quantities of stable manure are available. The second smaller group contains one or two heavy soils, though land that is equally strong or even stronger will generally be found under cultivation.

Table VII. TYPICAL WASTE AND COMMON SOILS.

	Too light for cultivation.									Soils heavy, wet, or lying too high for cultivation.	
Formation ..	Folkestone beds.				Bag-shot beds.	Hythe beds.	Old-haven beds.	Ash-down beds.	Chalk.	London Clay.	Clay-with-Flints.
Locality ..	Hoth-field Com-mon. 14.	Black-heath (Surrey). 170.	Seale. 32.	Nr. Hart-ing. 192.	Brook-wood. 91.	Leith Hill. 168.	Hayes. 76.	Wych Cross. 241.	Open Downs East-bourne. 253.	Ash-tead Com-mon. 57.	Elham. 157.
Fine Gravel, above 1 m.m.	·1	1·2	2·1	·8	·7	4·2	6·8	·2	·5	·1	·5
Coarse Sand, 1–0·2 m.m.	68·5	65·9	37·7	59·7	16·6	12·7	12·8	·3	·6	5·5	·5
Fine Sand, 0·2–0·04 m.m.	18·1	23·7	47·6	22·1	64·2	51·6	36·1	53·2	5·3	23·0	33·5
Silt, 0·04–0·01 m.m.	4·3	2·4	3·2	3·9	7·1	10·9	16·0	19·9	5·5	14·9	32·9
Fine Silt, 0·01–0·002 m.m.	2·3	2·0	2·3	3·8	3·9	5·5	8·3	10·1	5·2	17·7	10·4
Clay, below 0·002 m.m.	·2	0·9	·7	2·7	1·0	3·4	3·3	5·9	5·2	21·3	11·0
Calcium carbonate									44·0	Nil.	trace.

CHAPTER V.

Building Stones and other Economic Products.

The formations that are developed in the south-east of England contain very little building stone that is of any value; although certain stones were much used locally when means of communication were more scanty, only one kind was ever exported outside its own district, and at the present time whatever stone is used in building is generally brought from a distance.

The Eocene Beds yield no building stone at all, nor does the Chalk in this district contain any of the harder layers which are used for building in other parts of the country. Among the South Downs many of the churches are faced with squared flints, the inside of the walls being made of rough flints and pieces of chalk; in the interior also of these churches, mouldings and other dressed stone work may be seen carved from blocks of chalk. Below the Chalk comes the Upper Greensand, which provides the most widely known building stone occurring in the district. From quarries near Reigate a fine-grained, white, freestone is obtained, which can be readily quarried and worked; from its similarity to Caen stone it had great repute among church builders, and was extensively used in the original fabric of Westminster Abbey, as well as in the local churches. Unfortunately, it does not resist the weather well, especially in a modern London atmosphere charged with smoke and traces of acid; the surface of the stone rapidly disintegrates and flakes away, so that much of the Reigate stone has had to be replaced. Unless very carefully selected this stone soon decays even in pure country air, and many of the recent church restorations in West Sussex, where it is also quarried, already show grievous disintegration. In the western extension of this formation harder layers of rock also occur, which are used for rough farm buildings, walls, &c.; this is a grey durable stone, which, however, is somewhat fissile and cannot be dressed or carved. Certain layers in the Upper Greensand are also worked for hearth-stones; this material is soft enough to be cut when freshly quarried and then hardens; it is a very fine-grained sandstone which resists the action of the fire. An old quarry near Reigate has recently been re-opened, and Gilbert White describes the same stone in the neighbourhood of Selborne.

In the Lower Greensand the Kentish Rag in the neighbourhood of Maidstone and southwards as far as Ashford, possesses considerable economic importance as a building and paving stone. It forms a very hard and durable calcareous sandstone, which is worked with difficulty and so is rarely used for dressed stone masonry. It is, however, excellent material for ashlar buildings, for walls, for the pavement of courts and entrances to yards, wearing extremely well despite the occurrence of numerous shell remains. The Bargate stone, which is quarried

in the neighbourhood of Godalming, much resembles the Kentish Rag, but is redder in colour, the Kentish Rag being typically grey. The rest of the Lower Greensand west of Maidstone yields little building stone; occasionally hard layers of dark red and brown "car-stone" occur in the sand, and are used for building walls and farmsteads, but it possesses little durability, and cannot be obtained in quantity. (*See also* p. 118.)

It has already been mentioned that the Weald Clay contains thin beds of fresh-water limestone, made up of the shells of *Paludina*. At one time this rock was much sought after, the layers being probed for in the soft clay with sharp iron rods. In most villages in the Weald some of it may be seen forming flagged causeways, doorsteps, &c., while for indoor work, in a polished state, it travelled still further. It takes a pleasant polish and makes a grey-figured marble, which, under the name of Bethersden or Petworth marble, was used in many of the churches in this district, either for the altar steps, as in Canterbury Cathedral, or for the polished columns in buildings of the Early English style, in which case it is often mistaken for the very similar Purbeck marble. Very beautiful mantel-pieces made of this marble are often to be found in the older houses.

In the Weald Clay also occurs another local stone which at one time was widely employed; this is the Horsham stone, a fine-grained fissile sandstone, which only occurs over a limited area in the neighbourhood of Horsham. All over the western part of the Wealden area, even down to the sea in West Sussex, the older buildings were roofed with Horsham Stone. With age it makes a beautiful roof, taking a delicate grey colour and forming a good ground for moss and lichen; unfortunately, the slabs are thick and the roof in consequence very heavy, so that it is only employed at the present time for a few houses in the construction of which expense is not counted.

The sandstones of the Lower Wealden Beds rarely possess any durability; they may be used for rough walls and farm buildings, but they rapidly decay and will not stand the least wear. Only in the neighbourhood of East Grinstead do quarries occur from which can be obtained fine-grained brown and grey freestones, which can be finely carved and possess considerable durability. This pleasing stone occurs in the interior of many of the churches and older houses all over the Weald. Boulders that represent the harder cores of the rock of this formation that has fallen from the cliffs west of Hastings, have always been collected and used in churches, castles, and other old buildings for some distance inland.

Deficient as this district is in building stones it is even more lacking in road-making material, especially in the Weald, where the badness of the roads has been notorious until within the last generation, when it has become possible to introduce granitic materials from Belgium, Cherbourg, or the Channel Isles.

The more modern formations yield no hard stone at all, if we may except the hard cores of Thanet Sand which are left

behind in places as boulders upon the chalk, and are known as "grey wethers." At one time these grey wethers were numerous on the Downs bordering the Medway, and there a few may still be seen, but the majority of them have been used in the farm buildings or have been broken up for mending the local roads. It is the flints that cover the surface of the Chalk formation which have provided the chief road-making material in the three counties, and on all the bye-roads they still form the bulk of the road stone. For this purpose the old weathered flints, which can be picked off the surface of the fields or which are found in quantities in some of the higher level gravel deposits, are much preferred to the fresh flints obtained from the chalk beds in the Upper White Chalk. The freshly won flints are found to be softer and much more readily fractured than those which have been exposed to the weather for some time. All over the Chalk formation it is customary for the farmers to pick the flints off the surface of the fields at intervals of a few years and sell them for road making. On the surface of the South Downs, a few inches below the turf, there occurs a layer of almost unmixed flints, below which the actual chalk rock sets in, and it is the custom to clean off the turf and sift out these flints for road making. For the greater part of the year roads made with flints maintain a good surface, though one which is rather wearing to footwear and wheels. The fine flint dust, however, possesses no binding power, so that after a spell of dry weather the roads become very loose, and the surface breaks up. Some binding material is desirable, as, for example, the harder beds of Kentish Rag. The modern roadmaker anywhere near the coast mixes with the flints a certain proportion of granite; before foreign material was available the soft chalk itself had to be used for this purpose. Below the Chalk no other road material is available until we come to the Lower Greensand. The Kentish Rag is extensively used for road making in its own district, but is generally too soft to stand anything beyond light local traffic. Between Maidstone and Sevenoaks, however, the Lower Greensand contains beds of very hard chert which is dug for road making, and yields a fairly durable surface. None of the Wealden formations contain any hard stone, and for some distance back from the coast in East Sussex the local roads are made with broken boulders drawn from the beach, consisting in the main of hard cores formed from the Wealden sandstone by weathering. All over the Weald, also, roads may occasionally be found made up with the slag from the old iron workings. These mounds of slag occur in places on the site of the old furnaces, but they are becoming rapidly exhausted.

Among other economic products of the same nature we may mention sand for glass making. This is obtained from the Lower Eocene near Chislehurst, or the Lower Greensand near Reigate and near Hollingbourne in East Kent. Fuller's Earth is also extensively dug on beds corresponding to the Sandgate series in the neighbourhood of Nutfield. It also used to be dug

in the beds in the Weald Clay, but the layers are not extensive enough to be worth working at the present time.

Though short of building stones the district is well provided with clays suitable for brick and tile making; the very name "Brick Earth" shows the suitability for brick-making purposes of that recent formation, and for a very long time the beds in North and East Kent have been exploited for the buildings of London. Sittingbourne is the present centre of the industry, and the yellow stock brick, which is the regular product, forms the material out of which the greater part of South London has been built. The London Clay in its unmixed form is too strong for bricks, though it can be used for making tiles. The proximity of the Bagshot Beds have in Surrey resulted in a good deal of material suitable for brick making, and the long series of small brickyards may be traced at the juncture of the London Clay and the Bagshot Sand throughout Surrey, though none of them possess more than local importance. The Gault similarly yields a clay which is most suitable for tile making, but, again, the proximity of the Folkestone Sand has provided the necessary admixture, and gives rise to a good material for brick making. Large brick and tile works exist on the Gault near Dunton Green, and again near Burham near the mouth of the Medway. Both the Weald Clay and the Lower Wealden provide beds in places suitable to brick and tile making, though, as a rule, the lack of coarse sand in the material derived from these formations results in brick which tends to warp and shrink a good deal in burning. The Weald Clay itself gives rise to very close-grained blue paving bricks if properly burnt without admixture. The suitability of any particular stratum in these formations for brick or tile making can be readily determined by consideration of the mechanical analyses.

The Chalk is always being burnt for lime, and the constant occurrence of small disused kilns along the line of the escarpment and, indeed, all over the formation shows how general this employment was at one time, probably for farming purposes as well as for building. At the present time the lime burning is confined to a few large firms, as, for example, at Erith, Dorking, and Lewes. For agricultural purposes the Upper White Chalk yields the best lime. As the following analyses show the Upper White Chalk and the lime derived from it are comparatively pure carbonate and oxide of lime, respectively. The resulting lime is in consequence what is called a "fat lime," which swells considerably on slaking and falls down into a fine powder. The middle beds of the Chalk without Flints are much less pure, and contain about 10 per cent of clay and sand mixed with the calcium carbonate. On burning it gives rise to what is known as "grey" lime, which is both harder in itself and does not swell to any great extent on slaking. Though better for mortar making because it partakes in some degree of the nature of cement, the grey lime is less valuable to the farmer. It contains a smaller proportion of lime and does not so readily become finely divided and mixed with the soil.

White Lime.

—	8. Burnham.	9. Burnham.	Dorking.	Farnham.
Caustic Lime	89·5	89·1	91·6	90·8
Carbonate of Lime	2·2	2·6	2·1	2·5
Magnesia	0·5	0·3	0·3	0·3
Ferric Oxide	0·6	0·66	0·41	0·4
Alumina	1·0	4·4	0·8	0·7
Silica as Sol. Silicates	3·1	3·6	1·8	1·9
Insoluble residue	0·1	0·5	0·15	0·24

Grey Lime.

—	1.	2.	3.	4.	5.	6.	7.
	Halling.		Burnham.		Dorking.		Farnham.
	Ground.	Lump.	Hy'lic.	Grey.	Lump.	Ground.	
Caustic Lime ...	53·3	74·4	63·3	73·8	74·5	69·6	77·2
Carbonate of Lime ...	9·1	5·8	1·5	1·8	1·5	4·9	2·7
Magnesia	1·32	0·33	0·54	0·42	0·31	0·32	0·29
Ferric Oxide ...	0·68	0·88	1·3	0·22	1·25	1·36	1·29
Alumina	8·1	4·4	16·6	10·6	3·5	3·4	3·3
Silica as Sol. Silicates	10·9	9·3	12·8	9·9	3·5	8·5	7·5
Insoluble residue ...	2·24	1·15	0·58	0·67	1 0	1·25	1·3

The white lime is generally used by plasterers, and is not as a rule ground to a powder by the lime works, though powdered white lime would be by far the best form of lime to use for agricultural purposes. One of the large lime companies also supplies powdered chalk for agricultural use, and this is a very good form of carbonate of lime, especially for use on sandy soils. Unfortunately, its cost is much increased by the freight that is to be paid, for it should be remembered that it takes nearly two parts of the carbonate of lime to do the work of one of quicklime. Where the carbonate of lime in the formations is naturally mixed with a good deal of clay, as in the upper beds of the Gault and in some of the beds of the Chalk Marl, the material will give rise to cement on being burnt. The great Portland cement industry which has developed along the estuary of the Thames and Medway, the Ouse and the Arun, depend upon mixing the chalk with a proper proportion of river mud before burning. At one time the nodules of argillaceous limestone, which occur in the London Clay and were collected by digging or even by dredging in the Thames and Medway estuaries, were extensively burnt for the cement that they yielded, but this material has been displaced by a cheaper mixture of chalk and river mud.

CHAPTER VI.

Descriptions and Analyses of Soils.

ALLUVIAL SOILS.

Romney Marsh Pasture Soils, Kent.

200. *Lydd.*—An excellent fatting field, reputed to be one of the best in Romney Marsh. The grass grows very fast and there is a beautiful thick turf; 100 sheep are sometimes turned on to the 2 acres (the area of the field). The field is situated next to the homestead.

198. *Lydd.*—Is next to the above and is a good fatting pasture, taking 6 to 8 sheep per acre in summer.

225. *Lydd.*—On the opposite side of the road. Is poor, and carries only 3 or 4 sheep per acre in summer without fattening them. There are a number of rushes here, but not in the fatting fields.

283. *Midley.*—A good fatting pasture, producing a beautiful close herbage.

273. *Midley.*—The next field separated only by a fence from 283, will not fat sheep, contains a number of rushes, and in June is yellow with buttercups, whilst the fatting field is almost free from them.

281. *Hope-all-Saints.*—A good fatting pasture.

275. *Hope-all-Saints.*—A poor pasture, only separated by a lane from 281.

226. *Orgarswick.*—A good fatting pasture; fats 6 sheep per acre without any help; as a rule they are mostly two-year olds, but tegs put in in early spring get fat by end of August. If it is not grazed too hard in the spring it seldom suffers from drought.

236. *Orgarswick.*—A poorer pasture. This field, which is next to the above, and separated from it only by a ditch, will just keep tegs growing throughout the summer. The grass grows away very fast in the spring and requires a good deal of stock to keep it back.

143. *Orgarswick.*—From a field about half-a-mile from the preceding, better than the poor field, but not as good as the fatting field.

Sandwich Marshes, Kent.

147. *Stonar.*—Very good pasture near the river; similar to the Romney Marsh fatting pastures. This land is known to have been reclaimed in the time of Edward III.

145. *Worth.*—Medium pasture, reclaimed before the preceding, but not as good.

277. *Richborough.*—Very good fatting pasture; sheep fatted here are said to produce more flesh in proportion to fat than those on Romney Marsh. It also yields excellent wool.

279. *Chislet.*—Fatting pasture, but not as good as 277, moreover does not yield as good a quality of wool.

Thames Marshes.

161. *Graveney.*—Famous fatting field.

177. *St. Mary, Hoo.*—Famous fatting field.

Pevensey Marshes, Sussex.

288. *West Ham.*—Old bullock pasture.

OTHER ALLUVIAL SOILS.

Wash from Lower Greensand.

140. *Yalding, Kent.*—Hop garden. This stretch of soil is also excellent apple land, and grows wheat very well, but is not so good for oats. It dries quickly, and requires a wet summer and also a dry winter. Early sowing is necessary. It is very "hungry" and will stand heavy dunging. Basic slag is useful, but potash has not been noticed to give good results.

103. *Nutfield, Surrey.*—From the valley north of Nutfield. Very fertile soil, excellent for mangolds, wheat, and oats, but not particularly suitable for potatoes; it cracks very little and can be worked in winter. It is not deflocculated by liquid manure, and receives with great benefit the drainage from the cowsheds at all times of the year.

Wash from Bagshot Beds.

189. *Weybridge, Surrey.*—Arable land, formerly market garden. Responds in a marked degree to lime.

295. *Merton, Surrey.*—Blowing sand.

296 and 297. *Merton, Surrey.*—Light soils, useful for market gardens. Require considerable dressings of dung.

Rother Valley, Sussex.

174. *Ewhurst.*—Excellent bullock pasture, much improved by basic slag.

285. *Ewhurst.*—Old pasture, not particularly good.

Lewes Level, Sussex.

272. *Beddingham.*—Pasture, grazed and hayed. Improved by basic slag.

CHAPTER VI.

Descriptions and Analyses of Soils.

ALLUVIAL SOILS.

Romney Marsh Pasture Soils, Kent.

200. *Lydd.*—An excellent fatting field, reputed to be one of the best in Romney Marsh. The grass grows very fast and there is a beautiful thick turf; 100 sheep are sometimes turned on to the 2 acres (the area of the field). The field is situated next to the homestead.

198. *Lydd.*—Is next to the above and is a good fatting pasture, taking 6 to 8 sheep per acre in summer.

225. *Lydd.*—On the opposite side of the road. Is poor, and carries only 3 or 4 sheep per acre in summer without fattening them. There are a number of rushes here, but not in the fatting fields.

283. *Midley.*—A good fatting pasture, producing a beautiful close herbage.

273. *Midley.*—The next field separated only by a fence from 283, will not fat sheep, contains a number of rushes, and in June is yellow with buttercups, whilst the fatting field is almost free from them.

281. *Hope-all-Saints.*—A good fatting pasture.

275. *Hope-all-Saints.*—A poor pasture, only separated by a lane from 281.

226. *Orgarswick.*—A good fatting pasture; fats 6 sheep per acre without any help; as a rule they are mostly two-year olds, but tegs put in in early spring get fat by end of August. If it is not grazed too hard in the spring it seldom suffers from drought.

236. *Orgarswick.*—A poorer pasture. This field, which is next to the above, and separated from it only by a ditch, will just keep tegs growing throughout the summer. The grass grows away very fast in the spring and requires a good deal of stock to keep it back.

143. *Orgarswick.*—From a field about half-a-mile from the preceding, better than the poor field, but not as good as the fatting field.

Sandwich Marshes, Kent.

147. *Stonar.*—Very good pasture near the river; similar to the Romney Marsh fatting pastures. This land is known to have been reclaimed in the time of Edward III.

145. *Worth.*—Medium pasture, reclaimed before the preceding, but not as good.

277. *Richborough.*—Very good fatting pasture; sheep fatted here are said to produce more flesh in proportion to fat than those on Romney Marsh. It also yields excellent wool.

279. *Chislet.*—Fatting pasture, but not as good as 277, moreover does not yield as good a quality of wool.

Thames Marshes.

161. *Graveney.*—Famous fatting field.

177. *St. Mary, Hoo.*—Famous fatting field.

Pevensey Marshes, Sussex.

288. *West Ham.*—Old bullock pasture.

OTHER ALLUVIAL SOILS.

Wash from Lower Greensand.

140. *Yalding, Kent.*—Hop garden. This stretch of soil is also excellent apple land, and grows wheat very well, but is not so good for oats. It dries quickly, and requires a wet summer and also a dry winter. Early sowing is necessary. It is very "hungry" and will stand heavy dunging. Basic slag is useful, but potash has not been noticed to give good results.

103. *Nutfield, Surrey.*—From the valley north of Nutfield. Very fertile soil, excellent for mangolds, wheat, and oats, but not particularly suitable for potatoes; it cracks very little and can be worked in winter. It is not deflocculated by liquid manure, and receives with great benefit the drainage from the cowsheds at all times of the year.

Wash from Bagshot Beds.

189. *Weybridge, Surrey.*—Arable land, formerly market garden. Responds in a marked degree to lime.

295. *Merton, Surrey.*—Blowing sand.

296 and 297. *Merton, Surrey.*—Light soils, useful for market gardens. Require considerable dressings of dung.

Rother Valley, Sussex.

174. *Ewhurst.*—Excellent bullock pasture, much improved by basic slag.

285. *Ewhurst.*—Old pasture, not particularly good.

Lewes Level, Sussex.

272. *Beddingham.*—Pasture, grazed and hayed. Improved by basic slag.

BRICK EARTH SOILS.

East Kent.

112. *Stourmouth.*—Cherry orchard, grassed over.

120. *Wickham.*—Hop garden.

129. *Ickham.*—Taken from a large uniform patch, arable and hops.

100. *Wye.*—Hop garden. During wet weather this soil becomes extremely sticky, and must not be worked or it will dry hard. After a heavy rain a cake forms on the surface which has to be broken in order to allow the young plant to push through. Liquid manure makes the land work unkindly. The subsoil makes excellent bricks.

North Kent.

133. *Teynham.*—Hop garden.

230. *Rainham.*—Arable land. Brick fields close by. This sample contains more gravel and coarse sand than usual, and is more like the "loam on chalk" than the true brick earths.

Sussex Maritime Region.

207. *Shopwyke.*—Soil, 8 inches or more deep, lying on gravel. Good sheep, barley, and swede land, but swedes are liable to Club. Lime is known to be beneficial. Soil is free working, but cracks somewhat on drying.

211. *Oving.*—Deeper soil; responds to lime, phosphates, and markedly to nitrate of soda, but not noticeably to potash. Good folding land, easily worked, dries quickly after rain, and cracks somewhat. Dry summers are wanted.

209. *Yapton.*—Soil easily worked, cracks somewhat. Subsoil very stiff.

CLAY-WITH-FLINTS SOILS.

East Kent.

159. *Stelling Minnis.* — Arable land. Has clearly been heavily chalked in the past.

155. *Elham.*—Arable land. This soil is in better mechanical condition than usual on this formation because of the high content of coarse sand. In consequence the swede crops are very good.

157. *Elham Park.*—Woodland, chiefly indifferent oak and chestnut.

153. *Waltham.*—Arable land, very wet and sticky.

137. *Molash.*—Good cherry orchard, formerly hop garden.

North Kent.

180. *Loyterton (Sittingbourne).*—(*a*) Arable land. (*b*) Hop garden.

135. *Rainham.*—Woodland.

131. *Meopham.*—Arable loam, no flints.

Surrey.

109. *Hamsey Green.*—Permanent pasture; was found to be too stiff to keep as arable. It easily becomes water-logged.

110. *Hamsey Green.*—Productive arable land. Responds well to basic slag, but is said to be injured by superphosphate. Works more easily than 109, in spite of its extra content of clay, because it is richer in calcium carbonate.

108. *Kenley.*—Arable land, lighter than usual on this formation. Is easy to work, drains easily, and does not become sticky. There were so many flints that it was difficult to take the sample.

111. *Coulsden.*—At one time a famous wheat field, producing heavy crops of high quality wheat, now rather poor permanent pasture.

BAGSHOT BEDS.

Lower Bagshot Beds.

87. *Horsell, Surrey.*—Old pasture, slightly damp, adjoining barren common land. No change in the soil occurred nor was there any pan to 2 feet, while a sand pit near showed at least 20 feet of sand. Pebbles were fairly numerous in places.

88. *Wisley, Surrey.*—Arable land, caked on the surface; adjoining was waste land. A sand pit just close showed 1 to 3 feet of soil, the subsoil being reddish brown, then pure sand, white or greenish in colour. About 4 feet down a thin layer (4 inches) of clay occurred, then sand to at least 12 or 15 feet There was no pan.

Middle Bagshot Beds.

89. *Windlesham, Surrey.*—Arable land. Dry coarse sand, very much caked and hard on top. Some pebbles. Subsoil lightens in colour and continues to a depth of 3 feet. No noticeable pan.

90. *Bisley, Surrey.*—Arable land. This land is not particularly early, but is suitable for most purposes, growing good roots, potatoes, and cereals, including wheat. It puddles readily when wet and then dries very steely.

Upper Bagshot Beds.

91. *Brookwood, Surrey.*—Land not in cultivation though growing good conifers, chiefly Scotch and Austrian pines. A

very hard pan occurs at about 1 foot below the surface, which sometimes has a thickness of 8-12 inches. Not many pebbles were found. No samples of the subsoil could be taken.

Outliers on London Clay.

104. *Claygate.*—Pasture for the last 10 years, before that arable, being particularly good for white wheat and other straw crops. It cannot be worked during the winter months.

106. *Tolworth.*—A barren field, which by no profitable means can be made productive.

LONDON CLAY.

65. *Blean, Whitstable, Kent.*—Arable land, brown sticky loam, changing to yellow, sticky clay at 10 inches. A few lumps of chalk were seen below the surface.

67. *Eastchurch, Sheppey.*—Old pasture, with a few pieces of chalk near the surface. A stiff, brown-red clay, gradually lightening in colour to the subsoil.

290 to 292. *Merton, Surrey.*—Samples taken respectively from the bottom, middle, and top of the field, the top being the *heavier* because some of the original surface soil has washed down. The surface soil at the top therefore approximates to the subsoil below.

293 and 294. *Merton, Surrey.*—A neighbouring field. This is all pasture land and has in the past been chalked.

107. *Tolworth, Surrey.*—Arable land. A yellowish-red clay, which cracks badly in dry weather. This is the stiffest sample of London clay obtained from Surrey, excepting a soil from Ashtead Common. It has in the past been heavily chalked, but the lumps are now about 12 inches down. Dung seems the only useful manure.

105. *Chessington.*—Arable land, excellent for wheat and late potatoes. The soil is grey, with bands of red.

57. *Ashtead Common, Surrey.*—A sticky brown loam, changing at 9 or 10 inches to a yellow clay, which becomes mottled with blue at 2 feet.

26. *Wanborough.*—Three-year-old pasture. Sticky brown loam, changing to heavy yellow clay at 14 inches.

THANET BEDS.

Oldhaven Beds, Kent.

76. *Hayes Common.*—The soil is very full of rounded black pebbles; the subsoil was so pebbly that it could not be sampled. An exposed section showed that a black layer occurred at 2½ to 4 feet; below that the soil was lighter in colour but very pebbly

through the entire depth (20 feet). The vegetation consisted of heather and gorse, with good birches and Spanish chestnut in places.

80. *Woodnesboro.*—Arable land, but strawberries and fruit are also grown. Early soil. Sandy loam, dark-coloured, changing to yellow-brown sand at 12 inches. A few flints and rounded black pebbles were found.

77. *Langley Park, West Wickham.*—Arable soil, a brown sandy loam, with black rounded pebbles, gradually lightening in colour to the subsoil. Fewer stones were found in the subsoil, but the general character remained unchanged to 2 feet. Caps of London Clay occur on the higher ground.

Thanet Beds (Light Soils), Kent.

678. *Goldstone (Sandwich).*—Fertile arable land. Better for wheat than for barley; grows fruit well. The soil is very responsive to organic nitrogenous manures, but not noticeably so to phosphates. It must not be worked when wet; it forms a hard crust on the surface after rain, through which plants do not easily make their way.

95. *Hoath.*—Hop garden. A deep loam lying at a lower level than the surrounding gravel, the latter being very thin and poor.

193. *Newington.*—Arable land; grows hops and fruit well. Is easily worked, even if wet, provided it is not too wet. Tends to cake after rain, but not to any serious extent. Responds well to organic nitrogenous manures, to chalk, kainit, and superphosphate, but not to basic slag.

64. *Teynham.* Potato land. Light loam just above the marshes, in high condition and notable for great crops.

181. *Swanley.*—Nursery garden, flowers being produced.

Thanet Beds (Heavier Soils).

118. *Barton.*—Hop garden. This soil works well soon after rain, but must not be touched when quite wet or it goes steely. It never dries out. Black pebbles are found. It responds well to superphosphate and to occasional dressings of lime. Bones and kainit are also useful.

63. *Chislet.*—Good arable soil, light, easily worked, apt to cake on drying after a heavy shower.

119. *Wickham.*—Arable soil. Some flints were found and a very few black pebbles. Responds to superphosphate and occasional dressings of lime. Bones and kainit are also used.

81. *Selling.*—Hop garden. Brown sandy loam, becoming a reddish loamy sand at 10 inches to 12 inches. A few pebbles and angular flints were found on the surface.

117. *Newington.*—Grassed orchard, part of which is notably less productive than the rest:—(*a*) the unproductive part, much the heavier of the two; (*b*) the productive part.

659. *Greenhithe.*—Market garden soil. Early potatoes, early peas, and other market garden crops and fruit do well. The land receives large dressings of dung, &c., of lime and of artificials. It practically never dries out.

Woolwich Beds.

96. *Walmstone.*

CHALK.

Kent.

61. *Minster, Thanet.*—Arable. Flinty sandy loam, without much change to subsoil. Chalk about 4 feet below. (Upper Chalk.)

62. *Minster, Thanet.*—Arable. Red flinty loam, showing very little change to subsoil. Chalk about 18 to 24 inches below surface. (Upper Chalk.)

66. *Sutton-by-Dover.*—Arable. Sandy sticky loam with many flints, becoming a little lighter in colour at 18 inches. The soil here is very deep, the chalk being in many places 12 to 18 feet down. (Upper Chalk.)

7. *Wye.*—Yellow-brown loam with flints, changing to red, sandy clay, very flinty at 15 inches. The chalk is about 3 feet 6 inches below the surface. Probably this soil represents a chalk wash on the brick earth lying on the chalk rock. (Lower Chalk.)

261. *Lenham.*—Pasture on the chalk marl terrace. (Lower Chalk.)

68. *Meopham.*—Brownish loam with flints, soil very variable, in some places 6 or 7 feet, in others only 1 foot, in depth. (Upper Chalk.)

252. *Horton Kirby.*—Highly cultivated arable soil.

Surrey.

59. *Fetcham.*—Arable, light loam, very flinty, passing into hard chalk at 9 to 10 inches. Sample only taken to 8 inches. (Upper Chalk.)

29. *Seale.*—New pasture on top of Hog's Back. Light chalky loam, passing into chalk with a few flints at 12 inches. (Upper Chalk.)

Sussex.

213. *Chilgrove.*—Arable loam, flinty; being in a valley the soil is rather deep.

266. *Patching.*—Arable loam, very flinty.

263. *Sadlescombe, Poynings.*—Flinty arable loam.

270. *Sadlescombe, Poynings.*—Red loam, better than 263, and containing very few flints.

269. *Lewes.*—Arable loam.

All the Sussex soils are greatly benefited by folding, and they usually respond to basic slag and kainit.

253. *Eastbourne.*—Open down land.

THE UPPER GREENSAND.

83. *Buckland, Surrey.*—Shallow black soil which dries very white on the surface. Soft and greenish sandstone just below, in several cases a full subsoil sample could not be drawn. Good land and does not readily dry out.

84. *Bentley, Hampshire.*—Hop garden. Rather more sticky and heavy than the Surrey sample (No. 83). Very good hop and wheat land.

85. *Binsted, Hampshire.*—Hop garden. Character similar to 84.

219. *Treyford, West Sussex.*—Pasture land. The Upper Greensand terrace is here about 1 mile wide; the sample was taken from a field near the centre.

220. *Firle, East Sussex.*—Arable field lying in the middle of the formation. Fairly stiff ground.

GAULT.

39. *Brook, Kent.*—Rushy old pasture, heavy loam, changing at 12 inches to light yellow. Blue clay with gritty particles at 43 inches. Flints on exposed surface.

40. *Brook, Kent.*—Old pasture. Dark brown loam, changing at 12 inches to a yellow clay. Flints on exposed surface.

37. *Alder Holt, Binsted, Hampshire.*—Old pasture, surface much cracked. Sticky light-brown loam, very wet, changes to heavy mottled clay at 10 inches.

217. *North of Bepton, West Sussex.*—Pasture, formerly plough land. Much benefited by basic slag.

221. *Ripe, East Sussex.*—Pasture.

LOWER GREENSAND.

Folkestone Beds. (*a*) Uncultivated Soils.

Kent.

13 and 14. *Hothfield Common.*

Surrey.

170. *Blackheath, near Chilworth.*

30. *Puttenham Common.*

32. *Seale.*

West Sussex.

192. *Down Park, Harting.*

All the above are light sands, chiefly covered with bracken and wood.

FOLKESTONE BEDS. (*b*) CULTIVATED SOILS.

Kent.

78. *Monk's Horton.*—Good arable land.

Surrey.

101. *Nutfield.*—Pasture, formerly sheep and barley land. The soil lies on the top of the hill, but does not readily dry out, and deep-rooting plants do not suffer from drought. It does not crack on drying. Ironstone lies below.

102. *Nutfield.* — Arable land, lower down on the slope towards the north. Produces good main crop potatoes, but is too late for earlies, doubtless because of the north slope. The soil is easily worked and does not crack on drying. Red builders' sand lies below.

126. *Redhill.*—Pasture, formerly arable. Much benefited by lime and potash manures. Turnips, cabbages, &c., are much subject to finger and toe.

82. *Buckland.*

124. *Shalford.*—Arable land, producing excellent malting barley, much improved by sheep. Benefited by lime, but artificial manures seem of little advantage. London dung is much used, but dries the soil out badly in a dry season. Much ironstone occurs in the subsoil.

203. *Eashing (Bargate Rock).*—Arable land, very responsive to manures. Improved by lime and folding. Does not readily dry out, in spite of its high situation, and is more productive than 124.

SANDGATE BEDS.

Kent.

79. *Monk's Horton.*—Old pasture.

73. *Godington.*—Old pasture.

122. *Repton.* — Hop garden. The soil produces malting barley and also oats, but is less satisfactory for wheat. Requires much dung, but is not good folding land.

Sussex.

222. *Rogate.*—Pasture. Fertile land much benefited by folding. Superphosphate is especially useful, so also is lime.

Hythe Beds.

Kent.

149. *Aldington.*—Arable loam, not very suitable for folding. Grows wheat and oats but not barley.

93. *Smeeth.*

72. *Little Chart.*

167. *Chart Court.*—Very old hop garden.

187.—*Otham.*—Arable land carrying tares. Now grows potatoes but formerly produced hops.

185. *Sutton Valence.*—Hop garden.

128. *Mereworth.*—Damson plantation on high ground just below the ridge.

128A. *Mereworth.*—Woodland on top of the ridge. The subsoil was so stony that samples could not be taken. The land falls away to the north and is mainly in ordinary farm crops, no hops being grown till lower levels are reached.

127. *East Farleigh.*—Old hop garden, very well manured, and highly productive, yielding good crops of high quality. The soil overlies the "pinnock" and responds to lime. It dries out somewhat in summer, and must not be worked when wet.

183. *Between Whitley and Dibdin, Sevenoaks.*—Hop garden. Several gardens lie in the dip from which this sample was taken, but most of the immediate neighbourhood is woodland.

152. *Loddington.*—Excellent fruit land, responds to lime.

Surrey.

45. *Limpsfield.*—Light arable land on the face of the escarpment.

168. *Leith Hill.*—Plateau at top. Soil very stoney.

50. *Witley.*—Very poor pasture, almost waste.

Sussex.

205. *Midhurst.*—Arable land on high ground north of Midhurst.

204. *Midhurst, King Edward VII. Sanatorium.*—Woodland.

248. *Stedham.*—Arable land producing good barley and swedes. Responds to superphosphate, but is not benefited by liming or kainit. Lying at the bottom of a long slope it does not easily dry out.

228. *Ripe.*—Light arable land, very responsive to manure, can be worked when wet.

WEALD CLAY.

70. *Woodchurch, Kent.*—Four-year-old pasture, rather poor, chiefly Crested Dogstail. Stiff yellow-brown loam, but rather lighter than 69. Broken ironstone occurred at a depth of 5 to 9 inches. Yellow clay continued to at least 2 feet.

287. *Bethersden, Kent.*—Old pasture.

43. Below *Sutton Valence, Kent.*—Cracked pasture. Mottled grey clay at 3½ feet. Found deep brown streaks at 3 feet.

97. *Lingfield, Surrey.*—From limestone ridge near Horley and Lingfield. A stiff yellow clay with limestone nodules. Very greasy.

98. *Lingfield, Surrey.*—Old pasture lying in the valley below limestone ridge. A stiff yellow clay with a fair amount of nodule ironstone.

69. *Woodchurch, Kent.*—Arable land carrying beans. Heavy yellow loam becoming lighter in colour to 2 feet. A little shingly ironstone from 9 to 18 inches. Chalk rubbish had been applied probably about 16 years ago, and small lumps of chalk were still plentiful in the surface soil.

71. *Woodchurch, Kent.*—Old pasture, fairly good herbage. Hard yellow brown loam with shingly ironstone at 1½ to 2 feet, then stiff yellow clay.

257. *Biddenden, Kent.*—Pasture much improved by basic slag, also by lime.

267. *Shaddoxhurst, Kent.*—Pasture wet and sticky, subsoil light yellow.

692. *East Sutton, Kent.*—Impoverished pasture, formerly excellent wheat land. Much benefited by basic slag.

86. *Staplehurst, Kent.*—Stiff pasture.

74. *Marden, Kent.*—Arable, recently ploughed up. Stiff yellow-brown loam lightening in colour to 2 feet. Some broken ironstone was found about 1 to 2 feet down.

52. *Cranleigh, Kent.*—Arable heavy yellow loam, gradually changing to yellow mottled clay. No stones or hard particles found. (Sample taken to 10 inches.)

75. *Between Hildenborough and Penshurst, Kent.*—Old pasture. Much sandstone in large lumps from 6 to 19 inches. Then a stiff yellow clay.

53. *Cranleigh, Kent.*—New pasture. Brown heavy loam, changing at 2 feet to mottled blue clay. Ironstone occurred at 1½ to 2 feet. Much improved by basic slag.

54. *Cranleigh, Kent.*—Old pasture. Brown loam gradually changing below 16 inches to yellow mottled clay, good for strong bricks and does not require admixture with sand. (Sample taken to 10 inches.)

55. *Cranleigh, Kent.*—Near sand pit. Old pasture. Heavy brown loam, changed to mottled clay at 14 inches, and to sand at 18 inches. Sand continued to at least 9 feet, hardening at bottom. (Sample taken to 10 inches.)

51. *Witley, Surrey.*—Weald or Atherfield Clay. Pasture laid down about 10 years. Brown stiff loam for about 10 inches, then 6 inches of small ironstone nodules, hard and shattery; finally yellow sticky clay with grey mottlings.

196. *North Chapel, Sussex.*—Old pasture land, much improved by basic slag. The subsoil (9 inches to 18 inches) is distinctly more sandy than the surface, but at a depth of 2 or 3 feet solid clay is found.

215. *Billingshurst, Sussex.*—Good pasture, much improved by lime, which had recently been applied.

255. *Lower Dicker, Sussex.*—Poor arable land.

HORSHAM STONE.

232. *Near Christ's Hospital, Horsham, Sussex.*—Pasture.

LOWER WEALDEN STRATA.

Ashdown Beds.

Lower Wealden Strata, Sussex.

197. *Forest Ridge.*—Forest land.

241. *Wych Cross.*—Open heath.

244. *Hartfield.*—Cultivated bean grattan. The land is wet and poor, and is mainly in wood.

Tunbridge Wells Beds.

246. *Greatham.*—Stubble; crowstone gravel at about 15 inches. Land poor, mainly in wood. Small lumps of chalk present in surface soil.

242. *Groombridge.*—Poor arable land, sand rock about 15 inches down.

289. *Ewhurst.*—Hop garden. Light soil, sandy when dry, very sticky when wet.

250. *Sedlescombe.*—Arable soil. Reddish soil, working easily and not caking in drought. Possibly Purbeck beds.

WADHURST CLAY.

239. *Ashurst.*—Heavy land, arable, much cracked. Some hops are grown here.

172. *Ewhurst.*—Hop garden. Very heavy working land.

179. *Rolvenden.*—Hop garden, yields heavy crops.

Locality	Romney Marshes (K.). Lydd.			Romney Marshes (K.). Midley.		
Number of Analysis	200.	198.	225.	283.	273.	
Mechanical Analysis.						
Soil.						
Fine gravel, above 1 m.m.	0·1	0·1	0·2	0·1	0·1	*1*
Coarse sand, 1–0·2 m.m.	0·9	0·5	0·9	2·3	1·2	*2*
Fine sand, 0·2–0·04 m.m.	66·7	58·0	67·2	48·6	37·6	*3*
Silt, 0·04–0·01 m.m.	7·2	9·9	7·4	23·5	25·5	*4*
Fine silt, 0·01–0·002 m.m.	11·4	12·1	6·7	4·7	6·2	*5*
Clay, below 0·002 m.m.	3·9	7·6	5·7	7·2	16·7	*6*
[2]Moisture	3·7	4·0	2·7	3·6	4·4	*7*
[2]Loss on ignition	6·2	9·2	7·4	9·5	8·8	*8*
[2]Calcium carbonate	0·02	Nil.	0·13	0·08	Nil.	*9*
Total	100·1	101·4	98·3	99·6	100·5	
Stones	2·3	0·0	2·2	Nil.	Nil.	*10*
Fine silt, 0·01–0·005 m.m.	5·3	6·9	3·0	1·8	4·1	*11*
„ 0·005–0·002 m.m.	6·0	5·2	3·6	2·9	2·0	*12*
Subsoils.						
Fine gravel, above 1 m.m.	0·1	0·1	Nil.	0·1	0·1	*13*
Coarse sand, 1–0·2 m.m.	0·9	0·5	0·9	0·3	1·0	*14*
Fine sand, 0·2–0·4 m.m.	68·2	57·9	72·2	36·8	34·3	*15*
Silt, 0·04–0·01 m.m.	7·0	11·6	5·5	13·6	21·9	*16*
Fine silt, 0·01–0·002 m.m.	8·4	8·0	9·1	17·2	9·4	*17*
Clay, below 0·002 m.m.	8·3	10·7	7·1	17·9	20·3	*18*
[2]Moisture	2·8	2·5	2·5	3·4	3·7	*19*
[2]Loss on ignition	3·9	4·9	4·4	6·9	6·6	*20*
[2]Calcium carbonate	Nil.	0·08	0·09	3·6	4·2	*21*
Total	99·6	96·3	101·8	99·8	101·5	
Stones	12·8	4·0	3·1	Nil.	Nil.	*22*
Fine silt, 0·01–0·005 m.m.	3·9	3·3	3·8	9·3	7·3	*23*
„ 0·005–0·002 m.m.	4·5	4·7	5·2	7·8	2·0	*24*
Chemical Analysis.						
Soil.						
Moisture	3·71	4·05	2·71	3·62	4·43	*25*
Loss on ignition	6·22	9·26	7·43	9·56	8·83	*26*
Nitrogen	0·334	0·356	0·296	0·406	0·393	*27*
Alumina, Al_2O_3	1·47	1·93	1·72	—	—	*28*
Oxide of Iron, Fe_2O_3	2·31	3·00	2·55	—	—	*29*
Oxide of Manganese, Mn_3O_4	Nil.	Nil.	Nil.	—	—	*30*
Magnesia, MgO	0·29	0·32	0·30	—	—	*31*
Lime, CaO	0·33	0·36	0·37	—	—	*32*
Carbonates*	0·02	Nil.	0·13	0·08	Nil.	*33*
Potash, K_2O	0·28	0·28	0·26	—	—	*34*
„ „ "Available"†	0·028	0·014	0·055	—	—	*35*
Phosphoric Acid, P_2O_5	0·134	0·126	0·101	—	—	*36*
„ „ "Available"†	0·013	0·008	0·007	—	—	*37*
Sulphuric Acid, SO_3	0·06	0·07	0·07	—	—	*38*
Subsoil.						
Moisture	2·85	2·51	2·52	3·41	3·70	*39*
Loss on ignition	3·98	4·96	4·41	6·89	6·60	*40*
Nitrogen	0·170	0·217	0·147	0·158	0·210	*41*
Carbonates*	Nil.	0·08	0·09	3·63	4·18	*42*
Potash, K_2O	0·365	0·40	0·366	—	—	*43*
Phosphoric Acid, P_2O_5	0·092	—	0·089	—	—	*44*

K. = Kent. Sy. = Surrey. Sx. = Sussex.

[2] These values are approximate only. More exact values are given under "Chemical Analysis."

* Reckoned as Carbonate of Lime, $CaCO_3$. † Soluble in 1% Citric Acid.

Soils.

	Romney Marshes (K.)—*cont.*					Sandwich Marshes (K.).		
	Hope-All-Saints.		Orgarswick.			Stonor.	Worth.	Rich-borough
	281.	275.	226.	236.	143.	147.	145.	277.
1	0·1	0·1	0·1	0·5	0·1	0·1	0·1	0·1
2	3·0	0·6	0·0	0·0	0·0	0·1	0·1	0·6
3	27·3	18·1	35·5	29·9	31·1	9·6	5·4	16·7
4	17·3	25·4	17·7	18·4	18·1	14·8	17·8	32·9
5	6·5	18·5	10·5	14·1	12·9	21·4	19·4	13·8
6	18·1	24·6	19·1	20·3	19·7	22·5	32·1	11·4
7	4·6	4·7	2·3	5·0	5·1	6·9	8·2	6·5
8	11·9	9·7	14·2	11·0	10·2	15·1	13·2	14·8
9	0·66	0·32	0·10	0·42	Nil.	7·7	2·53	3·16
	89·4	102·0	99·5	99·6	97·2	98·2	98·8	99·9
10	Nil.	Nil.	Nil.	Nil.	—	—	—	Nil.
11	4·5	10·0	6·7	8·1	9·4	9·6	8·6	7·1
12	1·9	8·5	3·8	6·0	3·5	11·8	10·7	6·7
13	0·1	0·5	Nil.	0·1	0·1	Nil.	0·1	0·1
14	3·5	0·7	0·1	Nil.	0·1	0·1	0·1	0·1
15	25·8	17·8	33·7	24·2	28·2	8·0	3·7	15·9
16	20·9	24·1	13·7	14·9	17·2	16·7	16·3	27·2
17	9·7	19·1	15·6	16·7	14·6	18·7	18·9	17·6
18	22·0	27·0	24·2	29·6	27·6	28·9	39·4	11·8
19	3·4	4·9	4·5	5·2	4·9	5·9	7·6	5·3
20	4·9	5·6	6·5	6·6	6·1	6·0	8·8	8·3
21	8·0	0·14	0·33	0·6	Nil.	14·2	0·9	7·2
	98·3	99·8	98·6	97·9	98·8	98·5	95·8	93·5
22	0·1	Nil.	Nil.	Nil.	—	—	—	Nil.
23	7·4	10·6	9·8	10·8	7·5	9·4	10·5	9·1
24	2·2	8·5	5·8	5·8	7·0	9·3	8·4	8·4
25	4·65	4·77	2·37	5·04	5·13	6·98	8·21	6·50
26	11·90	9·64	14·21	11·06	10·27	15·12	13·24	14·80
27	0·445	0·327	0·445	0·383	0·411	0·633	0·552	0·584
28	—	—	3·89	4·91	6·05	7·88	9·00	—
29	—	—	3·62	3·82	4·11	4·82	5·35	—
30	—	—	0·08	0·18	Trace.	Nil.	Nil.	—
31	—	—	0·64	0·71	0·30	0·60	0·61	—
32	—	—	0·80	0·86	0·49	3·77	1·30	—
33	0·66	0·32	0·10	0·42	Nil.	7·7	2·53	3·16
34	—	—	0·56	0·66	0·81	0·96	1·12	—
35	—	—	0·044	0·070	0·023	0·055	0·043	—
36	—	—	0·149	0·116	0·150	0·146	0·119	—
37	—	—	0·010	0·007	0·015	0·013	0·018	—
38	—	—	0·09	0·09	0·12	0·17	0·16	—
39	3·40	4·96	4·58	5·22	4·99	5·98	7·67	5·39
40	4·95	15·54	6·53	6·64	6·15	6·07	8·89	8·29
41	0·206	0·133	0·212	0·184	0·185	0·198	0 230	0·253
42	8·00	0·14	0·33	0·60	Nil.	14·2	0·93	7·20
43	—	—	0·77	0·92	0·98	1·11	1·40	—
44	—	—	0·127	0·083	0·098	0·129	0·112	—

Alluvial

Locality	Thames Marshes (K.).			Pevensey Marshes.	Yald-ing.	
	Chislet.	Grave-ney.	Hoo.	West Ham.		
Number of Analysis	279.	161.	177.	288.	140.	
Mechanical Analysis.						
Soil.						
Fine gravel, above 1 m.m. ...	0·1	0·1	0·1	0·1	3·2	1
Coarse sand, 1–0·2 m.m. ...	0·6	0·2	0·1	0·2	13·1	2
Fine sand, 0·2–0·04 m.m. ...	8·2	8·4	7·7	15·8	40·0	3
Silt, 0·04–0·01 m.m.	30·6	13·3	14·4	16·5	16·5	4
Fine silt, 0·01–0·002 m.m. ...	9·3	23·6	20·9	20·8	9·0	5
Clay, below 0·002 m.m.	16·3	27·7	30·2	24·6	9·1	6
Moisture	5·9	8·0	6·6	5·7	2·1	7
Loss on ignition	14·3	17·1	12·7	13·3	4·0	8
Calcium carbonate	4·3	0·05	0·05	0·1	0·1	9
Total	89·6	98·5	92·8	97·1	97·1	
Stones	Nil.	—	—	—	—	10
Fine silt, 0·01–0·005 m.m. ...	2·7	9·6	9·2	12·0	7·1	11
„ 0·005–0·002 m.m. ...	6·6	13·9	11·6	8·7	1·9	12
Subsoils.						
Fine gravel, above 1 m.m. ...	0·1	0·1	0·1	0·1	1·5	13
Coarse sand, 1–0·2 m.m.	0·2	0·1	0·1	0·1	11·5	14
Fine sand, 0·2–0·4 m.m.	21·2	8·1	3·6	12·7	39·3	15
Silt, 0·04–0·01 m.m.	15·2	13·5	18·4	16 7	14·9	16
Fine silt, 0·01–0·002 m.m. ...	17·4	18·9	18·7	20·6	12·9	17
Clay, below 0·002 m.m.	14·5	31·0	44·9	32·6	14·1	18
Moisture	4·4	6·8	6·6	5·7	2·1	19
Loss on ignition	6·9	8·4	7·9	6·5	3·2	20
Calcium carbonate	12·7	0·6	0·04	2·5	0·01	21
Total	92·6	87·5	99·4	97·5	99·6	
Stones	—	—	—	—	—	22
Fine silt, 0·01–0·005 m.m. ...	8·9	10·4	11·8	12·2	7·9	23
„ 0·005–0·002 m.m. ...	8·5	8·5	6·9	8·3	4·9	24
Chemical Analysis.						
Soil.						
Moisture	5·99	8·08	6·64	5·74	2·12	25
Loss on ignition	14·27	17·16	12·78	13·30	4·07	26
Nitrogen	0·571	0·605	0·457	0·537	0·145	27
Alumina, Al_2O_3	—	7·97	7·32	2·74	3·10	28
Oxide of Iron, Fe_2O_3	—	5·33	5·80	3·71	3·98	29
Oxide of Manganese, Mn_3O_4 ...	—	Trace.	Trace.	Trace.	0·03	30
Magnesia, MgO	—	0·50	1·29	0·57	0·20	31
Lime, CaO	—	0·44	0·52	0·75	0·30	32
Carbonates*	4·30	0·05	0 05	0·10	0·09	33
Potash, K_2O	—	1·08	0·99	0·38	0·59	34
„ „ "Available" † ...	—	0·069	0·063	0·038	0·044	35
Phosphoric Acid, P_2O_5	—	0·187	0·176	0·126	0·258	36
„ „ "Available" †	—	0·023	0·019	0·019	0 080	37
Sulphuric Acid, SO_3	—	0·12	0·12	0·15	—	38
Subsoil.						
Moisture	4·48	6·84	6·60	5·75	2·19	39
Loss on ignition	6·89	8·42	7·96	6·50	3·24	40
Nitrogen	0·212	0·196	0·170	0·150	0·076	41
Carbonates *	12·78	0·62	0·04	2·5	0·01	42
Potash, K_2O	—	1·40	1·53	0·35	0·49	43
Phosphoric Acid, P_2O_5	—	0·129	0·091	0·080	0·126	44

*Reckoned as Carbonate of Lime, $CaCO_3$. † Soluble in 1% Citric Acid.

Soils—*continued.*

	Nutfield, Sy.	Wey-bridge, Sy.	Merton, Sy.			Rother Alluvials (Sx.). Ewhurst.		Lewes Level. Bedding-ham.
	103.	189.	295.	296.	297.	174.	285.	272.
1	1·8	1·3	1·7	1·2	1·4	0·7	0·1	0·1
2	14·8	38·4	65·6	55·9	52·0	1·0	0·5	0·1
3	27·6	39·9	10·3	12·0	14·8	19·8	19·3	4·0
4	24·4	5·6	7·7	9·6	9·2	28·4	13·0	10·9
5	10·3	5·1	1·8	4·6	6·1	12·1	20·0	16·8
6	11·9	3·8	4·4	7·8	10·0	19·7	26·9	35·1
7	2·6	1·6	2·6	2·7	2·8	4·7	4·0	9·5
8	4·5	3·8	2·8	2·6	1·6	10·2	11·3	14·8
9	0·07	0·3	0·05	—	—	0·05	0·28	3·76
	98·0	99·8	97·0	96·4	97·9	96·7	95·3	95·1
10	—	—	6·3	5·0	4·0	—	—	—
11	7·6	1·8	1·2	2·8	4·3	5·0	10·8	7·1
12	2·7	3·3	0·5	1·8	1·7	7·0	9·2	9·6
13	1·5	0·6	1·0	1·1	1·1	0·4	0·1	0·1
14	11·1	45·5	66·3	55·5	52·2	0·7	0·2	0·1
15	26·9	36·8	11·4	13·2	14·1	19·8	16·6	4·5
16	28·0	5·1	6·5	8·8	8·6	22·2	13·1	12·4
17	10·2	5·1	3·5	5·5	5·9	10·2	21·9	12·8
18	17·5	3·5	5·6	9·3	12·2	30·5	35·1	48·4
19	2·3	1·3	1·9	2·3	3·0	4·5	3·8	7·9
20	2·7	1·9	3·9	3·3	2·7	7·3	8·8	10·6
21	Trace.	0·04	Nil.	—	—	Nil.	0·19	0·6
	100·2	99·9	100·1	99·0	99·8	95·6	99·8	97·4
22	—	—	4·5	5·0	3·5	—	—	—
23	7·2	3·1	2·6	3·7	4·0	4·4	9·7	5·8
24	3·0	2·0	0·8	1·8	1·9	5·7	12·2	6·9
25	2·61	1·62	2·65	2·71	2·80	4·76	4·00	9·52
26	4·51	3·86	2·81	2·61	1·66	10·21	11·33	14·82
27	0·184	0·117	0·200	0·202	0·166	0·339	0·354	0·611
28	3·66	0·85	—	—	—	6·45	—	—
29	3·20	2·67	—	—	—	4·26	—	—
30	Trace.	0·14	—	—	—	Nil.	—	—
31	0·37	0·12	—	—	—	0·30	—	—
32	0·48	0·37	—	—	—	0·81	—	—
33	0·07	0·35	0·05			0·05	0·28	3·76
34	0·30	0·12	0·11	0·17	0·08	0·51	0·22	0·82
35	0·012	0·032	0·006	—	0·008	0·031	0·014	0·026
36	0·123	0·131	0·108	0·108	0·099	0·343	0·102	0·140
37	0·025	0·040	0·045	0·051	0·035	0·064	0·006	0·020
38	0·05	0·04	—	—	—	0·08	—	—
39	2·32	1·38	1·94	2·37	3·01	4·55	3·84	7·90
40	2·73	1·92	3·01	3·33	2·70	7·33	8·84	10·61
41	0·063	0·063	0·100	0·122	0·091	0·173	0·202	0·286
42	Trace.	0·04	Nil.	—	—	Nil.	0·19	0·60
43	—	—	0·08	0·21	0·13	0·75	0·34	0·74
44	—	—	0·084	0·089	0·052	0·245	0·079	0·040

Locality	Stour-mouth, K.	Wickham, K.	Ickham, K.	
Number of Analysis	112.	120.	129.	
Mechanical Analysis.				
Soil.				
Fine gravel, above 1 m.m.	0·8	0·3	0·3	*1*
Coarse sand, 1–0·2 m.m.	1·2	0·8	0·7	*2*
Fine sand, 0·2–0·04 m.m.	27·5	30·2	24·7	*3*
Silt, 0·04–0·01 m.m.	40·9	43·7	44·8	*4*
Fine silt, 0·01–0·002 m.m.	9·8	7·8	8·6	*5*
Clay, below 0·002 m.m.	13·1	10·4	14·7	*6*
Moisture	2·6	2·2	2·4	*7*
Loss on ignition	4·3	4·4	4·6	*8*
Calcium carbonate	0·14	0·28	0·40	*9*
Total	100·3	100·1	101·2	
Stones	—	—	—	*10*
Fine silt, 0·01–0·005 m.m.	7·9	5·9	6·7	*11*
„ 0·005–0·002 m.m.	1·9	1·9	1·9	*12*
Subsoils.				
Fine gravel, above 1 m.m.	0·2	0·3	Nil.	*13*
Coarse sand, 1–0·2 m.m.	0·7	0·4	0·3	*14*
Fine sand, 0·2–0·04 m.m.	26·4	29·5	25·3	*15*
Silt, 0·04–0·01 m.m.	38·1	37·8	39·5	*16*
Fine silt, 0·01–0·002 m.m.	10·8	10·7	9·0	*17*
Clay, below 0·002 m.m.	15·2	14·6	12·2	*18*
Moisture	3·2	2·0	3·1	*19*
Loss on ignition	2·8	3·0	3·0	*20*
Calcium carbonate	0·14	0·24	0·08	*21*
Total	97·5	98·5	92·5	
Stones	—	—	—	*22*
Fine silt, 0·01–0·005 m.m.	7·4	7·3	7·1	*23*
„ 0·005–0·002 m.m.	3·3	3·3	1·9	*24*
Chemical Analysis.				
Soil.				
Moisture	2·69	2·28	2·45	*25*
Loss on ignition	4·37	4·44	4·65	*26*
Nitrogen	0·142	0·174	0·120	*27*
Alumina, Al_2O_3	4·07	2·64	3·33	*28*
Oxide of iron, Fe_2O_3	2·57	2·36	2·50	*29*
Oxide of Manganese, Mn_3O_4	Nil.	0·03	0·05	*30*
Magnesia, MgO	0·44	0·45	0·52	*31*
Lime, CaO	0·57	0·74	0·82	*32*
*Carbonates	0·14	0·28	0·40	*33*
Potash, K_2O	0·45	0·31	0·31	*34*
†"Available"	0·026	0·030	0·010	*35*
Phosphoric Acid, P_2O_5	0·113	0·149	0·074	*36*
†"Available"	0·030	0·052	0·008	*37*
Sulphuric Acid, SO_3	0·04	0·04	0·03	*38*
Subsoil.				
Moisture	3·26	2·05	3·15	*39*
Loss on ignition	2·80	3·09	3·00	*40*
Nitrogen	0·098	0·075	0·078	*41*
*Carbonates	0·14	0·24	0·08	*42*
Potash, K_2O	0·45	0·41	0·46	*43*
Phosphoric Acid, P_2O_5	0·063	0·073	0·067	*44*

* Reckoned as Carbonate of Lime, $CaCO_3$. † Soluble in 1% Citric Acid.

Earth.

	Wye, K.	Teynham, K.	Rainham, K.	Shopwyke, Sx.	Oving, Sx.	Yapton, Sx.
	100.	133.	230.	207.	211.	209.
1	1·0	0·7	3·2	0·6	0·9	0·5
2	3·0	2·1	4·2	0·8	1·3	1·8
3	27·2	39·1	32·6	25·0	16·0	28·2
4	40·0	26·1	15·3	27·3	35·5	35·5
5	8·9	8·6	8·9	16·4	13·3	13·3
6	11·2	11·7	14·3	11·1	15·9	11·1
7	1·7	3·4	3·6	2·5	3·3	2·3
8	5·5	5·3	8·4	4·7	6·5	3·8
9	0·18	0·14	0·75	0·02	0·75	0·06
	98·7	97·1	91·2	88·4	93·4	96·6
10	—	—	—	12·0	6·9	2·1
11	6·5	5·5	6·1	11·0	9·1	9·4
12	2·4	3·1	2·8	5·4	4·2	3·9
13	0·2	0·5	1·2	0·1	0·4	0·5
14	1·9	1·3	2·9	0·4	0·8	1·3
15	25·3	41·7	35·5	21·9	19·3	28·3
16	41·4	25·3	16·0	38·0	35·8	37·5
17	9·6	8·6	11·1	15·2	12·7	12·5
18	14·5	14·3	16·5	15·7	20·1	13·5
19	2·3	2·9	3·6	2·4	3·2	2·0
20	3·6	3·3	5·4	3·4	4·9	3·0
21	0·1	Nil.	0·45	0·02	0·66	0·01
	98·9	97·9	92·6	97·1	97·8	98·6
22	—	—	11·3	3·9	1·7	0·2
23	7·0	5·7	9·2	10·9	9·6	9·5
24	2·5	2·9	1·9	4·2	3·1	3·0
25	1·76	3·48	3·67	2·58	3·32	2·34
26	5·56	5·32	8·46	4·75	6·58	3·80
27	0·226	0·198	0·256	0·203	0·220	0·171
28	3·83	3·67	3·03	4·05	5·50	4·19
29	2·70	2·53	4·28	2·53	3·05	2·45
30	Nil.	0·09	0·09	Trace.	0·06	0·06
31	0·26	0·41	0·38	0·42	0·40	0·24
32	0·42	0·57	1·56	0·49	1·79	0·40
33	0·18	0·14	0·75	0·02	0·75	0·06
34	0·40	0·44	0·31	0·32	0·43	0·35
35	0·040	0·032	0·026	0·029	0·014	0·018
36	0·282	0·161	0·284	0·136	0·138	0·097
37	0·119	0·083	0·111	0·021	0·020	0·009
38	0·07	0·02	0·07	0·06	0·06	0·06
39	2·34	2·94	3·66	2·41	3·21	2·05
40	3·67	3·30	5·46	3·46	4·94	3·01
41	0·101	0·111	0·216	0·114	0·139	0·102
42	0·10	0·03	0·45	0·02	0·66	0·01
43	0·34	0·44	0·46	0·51	0·47	0·42
44	0·112	0·055	0·248	0·101	0·101	0·092

Clay

Locality	Stelling Minnis, K.	Elham, K.	Elham Park, K.	Waltham, K.	Molash, K.	
Number of Analysis	159.	155.	157.	153.	137.	
Mechanical Analysis.						
Soil.						
Fine gravel, above 1 m.m. ...	1·9	1·0	0·5	0·9	1·2	1
Coarse sand, 1–0·2 m.m. ...	1·3	12·2	0·5	1·6	1·4	2
Fine sand, 0·2–0·04 m.m. ...	28·4	26·8	33·5	27·3	34·0	3
Silt, 0·04–0·01 m.m.... ...	19·5	19·0	32·9	32·3	25·4	4
Fine silt, 0·01–0·002 m.m. ...	9·4	7·5	10·4	12·0	10·2	5
Clay below, 0·002 m.m. ...	21·5	21·1	11·0	15·4	14·4	6
Moisture	3·6	3·3	2·8	2·8	3·7	7
Loss on ignition	6·6	5·2	6·4	5·1	6·8	8
Calcium carbonate	3·6	1·5	0·02	0·07	0·37	9
Total	95·8	97·6	98·1	97·5	97·5	
Stones...						10
Fine silt, 0·01–0·005 m.m. ...	7·0	4·7	8·1	7·8	8·4	11
„ 0·005–0·002 m.m.	2·4	2·8	2·3	4·2	1·8	12
Subsoils.						
Fine gravel, above 1 m.m. ...	1·3	2·0	0·3	3·1	0·8	13
Coarse sand, 1–0·2 m.m. ...	1·1	13·9	0·5	1·0	1·2	14
Fine sand, 0·2–0·04 m.m. ...	21·9	21·1	27·9	22·7	32·1	15
Silt, 0·04–0·01 m.m.... ...	24·1	10·9	38·6	29·2	27·1	16
Fine silt, 0·01–0·002 m.m. ...	8·4	5·8	9·3	10·2	10·2	17
Clay, below 0·002 m.m. ...	28·8	33·0	13·8	22·8	16·8	18
Moisture	4·4	4·7	2·2	3·3	3·5	19
Loss on ignition	6·2	5·9	4·0	4·1	4·4	20
Calcium carbonate	0·46	0·33	0·09	0·16	0·63	21
Total	96·7	97·6	96·7	96·6	96·7	
Stones...						22
Fine silt, 0·01–0·005 m.m. ...	5·3	3·3	5·7	7·0	7·0	23
„ 0·005–0·002 m.m.	3·1	2·4	3·6	3·2	3·1	24
Chemical Analysis.						
Soil.						
Moisture	3·62	3·33	2·80	2·81	3·76	25
Loss on ignition	6·65	5·20	6·48	5·14	6·85	26
Nitrogen	0·215	0·134	0·179	0·152	0·251	27
Alumina, Al_2O_3	6·31	6·09	4·30	4·97	4·90	28
Oxide of Iron, Fe_2O_3 ...	4·92	4·74	2·94	3·60	3·34	29
Oxide of Manganese, Mn_3O_4	Nil.	0·12	0·10	0·09	0·10	30
Magnesia, MgO	0·38	0·25	0·30	0·22	0·22	31
Lime, CaO	3·29	1·82	0·21	0·82	0·78	32
*Carbonates	3·6	1·5	0·02	0·07	0·37	33
Potash, K_2O	0·37	0·42	0·35	0·39	0·34	34
†"Available"	0·038	0·047	0·028	0·047	0·033	35
Phosphoric Acid, P_2O_5 ...	0·160	0·102	0·071	0·118	0·130	36
†"Available"	0·010	0·010	0·012	0·014	0·025	37
Sulphuric Acid, SO_3 ...	0·07	0·02	0 05	0·06	0·07	38
Subsoil.						
Moisture	4·40	4·76	2·25	3·38	3·51	39
Loss on ignition	6·23	5·93	4·00	4·14	4·46	40
Nitrogen	0·125	0·086	0·073	0·096	0·138	41
* Carbonates	0·46	0·33	0·09	0·16	0·63	42
Potash, K_2O	—	0·45	0·23	0·33	0·35	43
Phosphoric Acid, P_2O_5 ...	—	0·080	0·067	0 067	0·105	44

* Reckoned as Carbonate of Lime, $CaCO_3$. † Soluble in 1% Citric Acid.

with Flints.

	Loyterton.		Rainham, K.	Meopham, K.	Hamsey Green, Sy.		Kenley, Sy.	Coalsden, Sy.
	180A.	180B.	135.	131.	109.	110.	108.	111.
1	1·1	0·6	1·4	1·8	1·6	1·7	1·9	1·7
2	1·0	0·8	0·7	3·6	9·5	5·3	23·0	5·7
3	30·7	33·7	32 9	44·1	22·3	28·7	19·7	26·5
4	24·9	29·3	27·4	15·4	25·4	26·3	21·2	20·5
5	9·4	8.5	10·1	7·6	9·9	10·2	10·3	9·6
6	18·7	13·0	14·8	15·5	16·0	16·4	13·4	20·0
7	3·3	2·5	3·6	3·7	2·8	2·9	2·4	3·7
8	5·0	4·7	6·1	4·3	5·2	4·8	3·9	5·5
9	0·76	0·74	0·06	1·45	0·48	1·02	0·4	0·5
	94·9	93·8	97·1	97·4	93·1	97·3	96·2	93·7
10								
11	6·4	7·6	7·2	4·5	7·5	7·9	7·3	7·7
12	2·2	0·9	2·9	3·0	2·4	2·3	2·9	1·8
13	—	—	1·6	2·0	3·1	1·4	2·8	1·8
14	—	—	0·7	2·8	6·7	7·1	15·8	3·7
15	—	—	29·0	40·3	28·0	25·1	18·4	20·5
16	—	—	29·8	16·6	22·5	17 6	17·1	19·7
17	—	—	9·5	7·6	12·6	9·5	12·7	10·2
18	—	—	18·5	18·3	16·4	28·3	21·6	31·4
19	—	—	4·4	4·0	3·0	3·8	3·6	4·8
20	—	—	4·1	4·1	3·7	4·8	3·6	5·5
21	—	—	0·05	2·0	0·08	0·28	0·07	0·33
	—	—	97·7	97·7	96·1	97·9	95·7	97·9
22								
23	7·2	—	6·6	5·1	8·7	6·4	7·9	6·9
24	0·9	—	2·9	2·5	3 8	3·1	4·7	3·2
25	3·37	2·55	3·65	3·79	2·85	2·95	2·42	3·78
26	5·06	4·46	6·10	4·30	5·27	4·88	3·92	5·56
27	0·182	0·173	0·172	0·149	0·20	0·174	0·154	0·180
28	5·49	3·93	6·17	4·66	—	2·81	2·95	5·94
29	3·68	2·94	1·61	3·47	—	3·59	4·34	3·84
30	0·08	0·06	0·08	0·10	—	0·01	0·10	0·08
31	0·51	0·46	0·38	0·42	—	0·28	0·20	0·25
32	1·12	1·08	0·65	0·78	—	0·92	0·55	0·66
33	0·76	0·74	0·06	1·45	0·48	1·02	0·40	0·57
34	0·40	0·34	0·34	0·35	0·29	0·37	0·20	0·39
35	0·003	0·004	0·064	0·014	0·009	0·007	0·007	0 007
36	0·105	0·124	0·048	0·112	0·117	0·158	0·110	0·127
37	0·017	0·025	0·007	0·021	0·011	0·006	0·007	0·008
38	0·04	0·05	—	0·09	—	0·06	0·04	0·05
39	—	—	4·43	4·05	3·01	3·85	3·67	4·83
40	—	—	4·18	4·12	3·73	4·79	3·68	5·56
41	—	—	0·093	0·106	0·103	0·084	0·079	0·106
42	—	—	0·05	2·06	0·08	0·28	0·07	0·33
43	—	—	0·400	0·363	0·239	0·415	0·283	0·458
44	—	—	0·052	0·085	0·107	0·062	0·119	0·100

Bagshot Sand.

Locality	Lower.		Middle.		Upper.	Outliers on L. Clay.	
	Horsell, Sy.	Wisley, Sy.	Windlesham, Sy.	Bisley, Sy.	Brookwood, Sy.	Claygate, Sy.	Tolworth, Sy.
Number of Analysis ...	87.	88.	89.	90.	91.	104.	106.
Mechanical Analysis.							
Soil.							
Fine gravel, above 1 m.m.	0·6	0·1	0·4	0·1	0·7	0·7	0·6
Coarse sand, 1–0·2 m.m. ...	20·7	17·1	26·6	29·5	16·6	24·8	37·8
Fine sand, 0·2–0·04 m.m.	47·1	66·4	48·6	47·5	64·2	38·6	33·1
Silt, 0·04–0·01 m.m. ...	7·4	3·5	10·[illegible]	5·3	7·1	11·2	7·7
Fine silt, 0·01–0·002 m.m.	9·5	3·9	5·3	5·8	3·9	6·1	4·7
Clay, below 0·002 m.m. ...	3·5	3·6	4·9	7·1	1·0	9·9	7·6
Moisture	2·0	0·7	1·6	2·1	0·9	2·3	1·5
Loss on ignition	6·4	3·3	3·5	3·2	4·4	3·9	3·6
Calcium carbonate ...	0·4	0·01	0·01	0·01	Nil.	Nil.	0·27
Total	97·6	98·7	101·3	100·7	98·8	97·5	96·8
Stones	1·9	2·4	4·9	3·8	8·1	—	3·3
Fine silt, 0·01–0·005 m.m.	4·8	2·6	3·7	3·7	2·7	4·1	2·7
„ 0·005–0·002 m.m.	4·7	1·3	1·5	2·0	1·1	1·9	2·0
Subsoils.							
Fine gravel, above 1 m.m.	0·3	0·1	2·1	0·1	0·7	2·2	0·4
Coarse sand, 1–0·2 m.m. ...	18·0	20·8	25·2	31·6	18·2	21·7	37·0
Fine sand, 0·2–0·04 m.m.	52·3	62·7	45·8	42·9	62·3	32·5	36·2
Silt, 0·04–0·01 m.m. ...	8·4	3·8	12·6	5·9	6·8	9·1	6·6
Fine silt, 0·01–0·002 m.m.	5·0	5·2	5·6	5·5	4·8	5·8	5·8
Clay, below 0·002 m.m. ...	4·9	4·0	5·7	9·9	1·4	18·4	7·5
Moisture	1·7	1·0	1·2	2·6	0·7	3·9	1·7
Loss on ignition	3·1	2·1	2·0	2·2	3·1	3·2	2·5
Calcium carbonate ...	0·01	0·04	0·1	0·02	Nil.	0·06	0·16
Total	93·8	99·8	100·3	100·8	98·0	96·9	97·9
Stones	—	3·3	—	3·0	—	—	—
Fine silt, 0·01–0·005 m.m.	3·0	3·1	3·6	2·4	3·5	3·3	3·0
„ 0·005–0·002 m.m.	1·9	2·1	2·0	3·0	1·3	2·5	2·8
Chemical Analysis.							
Soil.							
Moisture	2·04	0·79	1·61	2·17	0·94	2·39	1·59
Loss on ignition	6·48	3·32	3·56	3·20	4·44	3·98	3·60
Nitrogen	0·199	0·100	0·141	0·120	0·086	0·114	0·182
Alumina, Al_2O_3	1·46	0·92	1·43	1·94	0·11	2·79	2·26
Oxide of Iron, Fe_2O_3 ...	1·21	0·57	1·97	4·86	0·32	2·18	1·73
Oxide of Manganese, Mn_3O_4	0·03	0·04	0·08	0·03	Nil.	Nil.	Nil.
Magnesia, MgO	0·22	0·12	0·36	0·52	0·03	0·28	0·21
Lime, CaO	—	—	—	—	0·08	0·28	0·48
*Carbonates	0·42	0·01	0·01	0·01	Nil.	Nil.	0·27
Potash, K_2O	0·18	0·31	0·39	1·40	0·06	0·24	0·21
†"Available"	0·012	0·021	0·029	0·027	0·006	0·009	0·013
Phosphoric Acid, P_2O_5 ...	0·081	0·046	0·057	0·061	0·017	0·068	0·088
†"Available"	0·011	0·012	0·012	0·023	0·003	0·013	0·022
Sulphuric Acid, SO_3 ...	0·08	0·032	0·084	0·036	0·014	0·03	0·03
Subsoil.							
Moisture	1·78	1·01	1·22	2·61	0·79	3·94	1·75
Loss on ignition	3·18	2·18	2·00	2·20	—	3·22	2·58
Nitrogen	0·158	0·067	0·105	0·084	0·050	0·067	0·061
*Carbonates	0·01	0·04	0·09	0·02	Nil.	0·06	0·16
Potash, K_2O	—	0·172	0·571	1·80	—	0·24	0·26
Phosphoric Acid, P_2O_5 ...	0·040	0·030	0·041	0·040	—	0·036	0·048

* Reckoned as Carbonate of Lime, $CaCO_3$. † Soluble in 1% of Citric Acid.

London Clay.

Locality	Blean, Whitstable, K.	East-church, Sheppey.	Merton (Sy.).					Tolworth, Sy.	Chessington.	Ashtead Common, Sy.	Wanborough.
			Bottom of Field.	Middle of Field.	Top of Field.	On Hill.	Half-way down				
Number of Analysis ..	65.	67.	290.	291.	292.	293.	294.	107.	105.	57.	26.
Mechanical Analysis.											
Soil.											
Fine gravel, above 1 m.m ..	0·4	0·5	0·6	0·5	0·2	1·5	1·7	0·4	0·6	0·1	0·6
Coarse sand, 1-0·2 m.m. ..	0·8	0·3	24·0	25·8	23·6	16·9	18·4	12·8	16·9	5·5	17·4
Fine sand, 0·2-0·04 m.m. ..	6·5	17·6	15·2	17·5	11·7	12·4	12·7	25·5	31·2	23·0	38·1
Silt, 0·04-0·01 m.m.	15·8	13·4	17·9	15·5	17·6	16·6	16·6	11·3	14·7	14·9	14·0
Fine silt, 0·01-0·002 m.m. ..	16·3	15·3	11·8	11·0	9·4	10·1	11·1	11·1	8·8	17·7	7·3
Clay, below 0·002 m.m. ..	40·5	36·8	22·0	21·5	25·7	26·7	24·6	23·7	14·9	21·3	12·8
Moisture	6·4	5·0	—	4·5	—	—	—	4·9	2·9	6·9	3·9
Loss on ignition	9·0	7·4	—	5·3	—	—	—	5·6	4·2	10·0	4·3
Calcium Carbonate	0·35	0·22	—	0·3	—	1·6	—	2·0	0·88	Nil.	0·07
Total	96·0	96·5	—	101·9	—	—	—	97·3	95·1	99·4	98·5
Stones	2·2	0·3	0·7	0·4	1·1	0·7	0·0	—	—	0·2	0·7
Fine Silt, 0·01-0·005 m.m. ..	10·7	6·8	8·9	7·5	6·7	7·8	7·8	7·5	6·2	9·8	4·5
„ 0·005-0·002 m.m. ..	5·6	8·4	2·8	3·4	2·6	2·2	3·2	3·6	2·6	7·9	2·7
Subsoils.											
Fine Gravel, above 1 m.m.	0·1	Nil.	0·2	0·3	0·3	0·3	1·3	0·5	0·4	Nil.	0·2
Course sand, 1-0·2 m.m. ..	0·5	0·1	23·5	22·0	16·6	8·4	23·6	6·7	10·0	0·7	13·7
Fine sand, 0·2-0·04 m.m. ..	4·6	14·4	11·4	16·2	9·1	12·7	11·3	15·4	31·6	23·3	29·8
Silt, 0·04-0·01 m.m.	9·3	10·8	17·2	16·5	15·8	13·4	18·0	11·9	8·8	18·1	15·0
Fine silt, 0·01-0·002 m.m. ..	19·3	16·5	8·4	8·5	9·3	9·8	11·4	12·9	7·6	14·7	9·5
Clay, below 0·002 m.m. ..	47·8	42·0	28·6	27·5	37·7	41·7	24·9	36·4	28·2	32·6	20·8
Moisture	6·2	4·6	—	5·3	—	—	—	6·8	5·3	4·2	2·9
Loss on ignition	7·3	6·5	—	3·7	—	—	—	5·0	6·6	6·0	3·8
Calcium Carbonate	0·1	1·2	—	Nil.	—	0·2	—	0·5	0·1	Nil.	0·1
Total	95·2	96·1	—	100·0	—	—	—	96·1	98·6	99·6	95·8
Stones	1·5	0·1	1·8	0·4	0·4	Nil.	1·0	—	—	Nil.	1·3
Fine silt, 0·01-0·005 m.m. ..	12·1	8·6	6·4	5·5	6·3	4·6	6·6	9·1	4·4	9·4	5·6
„ 0·005-0·002 m.m. ..	7·1	7·8	1·9	3·0	2·9	5·1	4·8	3·8	3·1	5·2	3·9
Chemical Analysis.											
Soil.											
Moisture	6·48	5·09	—	4·57	—	—	—	4·92	2·92	6·90	3·91
Loss on ignition	9·08	7·42	—	5·32	—	—	—	5·61	4·29	10·06	4·38
Nitrogen	0·276	0·172	—	0·120	—	—	—	0·241	0·147	0·33	0·187
Alumina, Al_2O_3	9·34	11·75	—	—	—	—	—	5·95	4·01	6·78	4·14
Oxide of iron, Fe_2O_3 ..	6·16	6·04	—	—	—	—	—	3·80	3·16	3·96	2·47
Oxide of Manganese, Mn_3O_4	0·15	0·14	—	—	—	—	—	0·03	Nil.	0·17	0·71
Magnesia, MgO	2·02	1·24	—	—	—	—	—	0·97	0·54	1·12	0·35
Lime, CaO	—	—	—	—	—	—	—	1·51	0·72	—	—
*Carbonates	0·35	0·22	—	0·30	—	1·59	—	2·00	0·88	Nil.	0·07
Potash, K_2O	1·13	1·44	—	0·34	—	—	—	0·54	0·40	0·76	0·33
†"Available"	0·026	0·035	—	0·007	—	—	—	0·016	0·011	0·013	0·017
Phosphoric Acid, P_2O_5 ..	0·119	0·111	—	0·035	—	—	—	0·118	0·097	0·093	0·065
†"Available"	0·008	0·012	—	0·005	—	—	—	0·019	0·024	0·006	0·015
Sulphuric Acid, SO_3 ..	0·069	0·054	—	—	—	—	—	0·05	0·04	0·11	0·036
Subsoil.											
Moisture	6·25	4·69	—	5·37	—	—	—	6·88	5·38	4·20	2·94
Loss on ignition	7·33	6·58	—	3·78	—	—	—	5·07	6·60	6·03	3·88
Nitrogen	0·138	0·084	—	0·089	—	—	—	0·097	0·061	0·116	0·064
*Carbonates	0·13	1·23	—	Nil.	—	0·23	—	0·52	0·14	Nil.	0·08
Potash, K_2O	1·63	1·41	—	0·281	—	—	—	0·572	0·516	1·09	0·68
Phosphoric Acid, P_2O_5 ..	0·097	0·105	—	0·028	—	—	—	0·042	0·018	0·051	0·032

* Reckoned as Carbonate of Lime, $CaCO_3$. † Soluble in 1% Citric Acid.

Locality	Oldhaven Sand.			Thanet beds,			
	Hayes, K.	Wood-nesboro', K.	West Wick-ham, K.	Gold-stone, K.	Hoath, K.	New-ington, K.	
Number of Analysis	76.	80.	77.	678.	95.	193.	
Mechanical Analysis.							
Soil.							
Fine gravel, above 1 m.m. ...	6·8	0·5	25·9	0·2	1·2	0·5	1
Coarse sand. 1–0·2 m.m. ...	12·8	1·5		15·3	9·0	16·9	2
Fine sand, 0·2–0·04 m.m. ...	36·1	64·3	39·1	44·9	43·9	57·3	3
Silt, 0·04–0·01 m.m.	16·0	17·9	15·6	17·3	23·3	8·2	4
Fine silt, 0·01–0·002 m.m. ...	8·3	3·8	5·5	6·3	6·7	3·9	5
Clay, below 0·002 m.m. ...	3·3	7·3	7·1	8·9	9·7	6·0	6
Moisture...	2·9	1·0	1·6	2·2	2·4	1·6	7
Loss on ignition	15·0	3·3	3·4	3·1	3·9	3·7	8
Calcium Carbonate	0·05	0·02	0·59	0·08	0·38	0·18	9
Total	101·3	99·7	98·7	98·3	100·5	98·3	
Stones	147·	4·2	15·3	3·3	—	—	10
Fine silt, 0·01–0·005 m.m. ...	5·0	2·9	4·0	4·3	4·0	2·5	11
„ 0·005–0·002 m.m. ...	3·2	0·8	1·5	1·9	2·6	1·4	12
Subsoil.							
Fine gravel, above 1 m.m. ...	—	0·1	0·8	—	2·2	0·2	13
Coarse sand, 1–0·2 m.m. ...	—	0·9	31·7	—	7·0	16·7	14
Fine sand, 0·2–0·04 m.m. ...	—	64·4	39·0	—	47·7	58·5	15
Silt, 0·04–0·01 m.m.	—	17·4	16·3	—	22·8	6·8	16
Fine silt, 0·01–0·002 m.m. ...	—	4·2	6·6	—	6·2	4·0	17
Clay, below 0·002 m.m. ...	—	8·9	7·7	—	11·7	6·9	18
Moisture...	—	2·0	1·2	—	1·7	1·5	19
Loss on ignition	—	1·9	2·1	—	3·0	2·8	20
Calcium Carbonate	—	0·01	0·12	—	0·2	0·1	21
Total	—	99·9	105·5	—	102·5	97·5	
Stones	—	3·9	9·3	—	12·5	—	22
Fine silt, 0·01–0·005 m.m. ...	—	2·9	5·0	—	4·3	2·5	23
„ 0·005–0·002 m.m. ...	—	1·2	1·6	—	1·8	1·4	24
Chemical Analysis.							
Soil.							
Moisture...	2·95	1·05	1·60	2·21	2·43	1·68	25
Loss on ignition	15·05	3·33	3·48	3·17	3·97	3·70	26
Nitrogen...	0·427	0·120	0·145	0·119	0·140	0·133	27
Alumina, Al_2O_3...	1·41	1·74	2·66	2·07	2·54	1·65	28
Oxide of Iron, Fe_2O_3	0·70	1·38	2·11	2·44	3·41	1·51	29
Oxide of Manganese, Mn_3O_4 ...	0·02	0·05	0·10	Trace.	0·01	Nil.	30
Magnesia, MgO	0·47	0·23	0·16	0·32	0·51	0·20	31
Lime, CaO	0·10	0·31	0·78	0·51	0·58	0·36	32
*Carbonates	0·05	0·02	0·59	0·08	0·58	0·18	33
Potash, K_2O	0·189	0·326	0·297	0·392	0·396	0·200	34
†"Available"	0·010	0·018	0·016	0·012	0·022	0·013	35
Phosphoric Acid, P_2O_5 ...	0·081	0·060	0·101	0·064	0·125	0·111	36
†"Available"	0·012	0·017	0·040	0·013	0·032	0·049	37
Sulphuric Acid, SO_3	1·38	0·053	0·049	0·04	0·04	0·06	38
Subsoil.							
Moisture...	—	2·04	1·26	—	1·75	1·50	39
Loss on ignition	—	1·93	2·15	—	3·05	2·81	40
Nitrogen...	—	0·084	0·042	—	0·091	0·081	41
*Carbonates	—	0·01	0·12	—	0·20	0·10	42
Potash, K_2O	—	0·384	0·371	—	0·448	0·231	43
Phosphoric Acid, P_2O_5 ...	—	0·054	0·068	—	0·105	0·091	44

* Reckoned as Carbonate of Lime, $CaCO_3$. † Soluble in 1% Citric Acid.

Sand.

	light soils.		Thanet beds, loams.							Wool-wich Beds, Walm-stone, K.
	Teyn-ham, K.	Swan-ley, K.	Barton Ash, K.	Chislet, K.	Wick-ham, K.	Selling, K.	Newington, K.		Green-hithe, K.	
	64.	181.	118.	63.	119.	81.	117A.	117B.	659.	96.
1	0·5	1·2	0·2	1·2	0·6	0·6	0·8	0·8	0·3	0·6
2	15·0	10·2	2·3	5·2	2·1	4·7	1·8	1·0	2·0	1·6
3	48·9	58·6	34·7	32·1	36·3	55·2	47·9	49·7	68·1	33·2
4	15·2	13·3	36·2	33·3	32·3	14·1	10·7	17·1	3·6	42·2
5	5·4	5·1	6·3	7·4	9·2	5·7	6·6	6·4	4·8	6·5
6	9·3	5·5	11·5	11·9	10·4	10·9	15·3	11·5	11·6	10·5
7	1·6	1·2	2·2	1·8	2·3	1·9	4·3	3·1	2·5	2·1
8	3·4	2·9	4·3	4·4	4·4	3·4	8·7	6·2	4·6	3·2
9	0·33	0·02	0·18	0·13	0·03	3·6	1·5	0·18	0·7	0·1
	99·6	98·1	97·9	97·4	97·7	100·1	97·6	96·0	98·2	100·0
10	2·5	—	0·5	3·5	3·5	—	1·0	0·8	3·5	4·3
11	3·9	3·7	4·8	5·2	7·6	3·1	4·0	3·4	3·1	4·7
12	1·5	1·3	1·5	2·1	1·6	2·5	2·5	2·9	1·7	1·8
13	0·4	0·7	0·1	0·1	0·3	0·3	0·1	0·3	—	0·2
14	13·7	10·5	1·2	2·6	0·6	4·2	0·3	0·8	—	1·2
15	42·6	57·4	38·0	26·9	30·3	55·4	50·9	52·8	—	26·7
16	17·1	13·9	28·9	40·8	32·9	14·4	10·4	16·9	—	44·2
17	6·6	4·8	7·9	7·9	9·1	5·7	5·7	6·4	—	8·9
18	11·5	6·0	14·6	15·6	14·2	12·6	21·1	14·3	—	14·3
19	1·7	1·1	2·6	3·5	2·6	2·1	4·8	2·9	—	1·9
20	2·4	2·9	3·0	2·7	3·6	2·8	4·3	3·9	—	2·9
21	0·05	0·05	0·03	0·05	Nil.	1·58	0·25	0·005	—	0·01
	96·1	97·4	96·3	100·2	93·7	99·1	97·8	98·4	—	100·4
22	8·0	—	—	1·3	—	7·4	0·3	1·3	—	—
23	4·7	4·1	5·8	5·6	6·9	3·8	3·6	4·3	—	6·5
24	1·9	0·7	2·1	2·2	2·1	1·8	2·0	2·0	—	2·4
25	1·62	1·24	2·27	1·85	2·38	1·91	4·37	3·14	2·57	2·11
26	3·46	2·95	4·32	4·46	4·40	3·49	8·76	6·27	4·68	3·27
27	0·156	0·100	0·140	0·182	0·150	0·136	0·271	0·249	0·20	—
28	2·34	1·70	3·46	4·18	3·40	3·49	3·76	3·00	2·99	—
29	2·10	1·70	2·56	2·71	2·30	2·75	3·79	2·55	2·94	—
30	0·135	Nil.	0·02	0·55	0·04	0·07	Trace.	Nil.	Trace.	0·14
31	0·26	0·23	0·46	0·39	0·43	0·85	0·67	0·44	0·41	0·56
32	0·58	0·18	0·67	0·50	0·44	1·54	2·33	0·48	0·96	0·47
33	0·33	0·02	0·18	0·13	0·03	3·66	1·50	0·18	0·72	0·09
34	0·354	0·217	0·404	0·427	0·299	0·573	0·444	0·341	0·427	0·492
35	0·019	0·014	0·015	0·018	0·048	0·005	0·059	0·067	0·014	0·011
36	0·095	0·084	0·119	0·092	0·111	0·127	0·209	0·137	0·123	0·072
37	0·044	0·026	0·048	0·020	0·023	0·043	0·080	0·030	0·043	0·008
38	0·010	0·03	0·05	0·080	0·05	0·027	0·07	0·06	0·07	0·18
39	1·71	1·19	2·67	3·56	2·60	2·18	4·84	2·97	—	1·98
40	2·49	2·94	3·09	2·78	3·69	2·84	4·30	3·92	—	2·94
41	0·042	0·063	0·088	0·095	0·090	0·096	0·099	0·126	—	0·079
42	0·05	0·05	0·03	0·05	Nil.	1·58	0·25	0·005	—	0·01
43	0·469	0·269	0·441	0·632	0·309	0·582	—	0·582	—	0·607
44	0·066	0·057	0·053	0·077	0·074	0·10	—	0·127	—	0·067

Locality	Minster, Thanet, K.		Sutton by Dover, K.	Wye, K.	Lenham, K.	Meopham, K.	
Number of Analysis ...	61.	62.	66.	7.	261.	68.	
Mechanical Analysis.							
Soil.							
Fine gravel, above 1 m.m.	0·6	0·5	0·5	1·2	1·0	0·6	1
Coarse sand, 1–0·2 m.m. ...	8·8	16·0	1·5	20·8	2·2	1·6	2
Fine sand, 0·2–0·04 m.m. ...	35·2	31·8	13·9	23·8	6·2	29·3	3
Silt, 0·04–0·01 m.m. ...	25·5	21·4	21·0	24·2	17·1	17·8	4
Fine silt, 0·01–0·002 m.m.	6·7	5·9	6·4	8·0	5·1	7·0	5
Clay, below 0·002 m.m. ...	14·6	12·6	23·5	9·3	8·6	20·8	6
Moisture	1·9	2·9	6·7	3·0	3·0	4·5	7
Loss on ignition	4·9	5·0	9·2	3·6	7·2	7·8	8
Calcium carbonate ...	1·9	3·7	18·1	7·9	49·7	12·2	9
Total	100·1	99·8	100·8	101·8	100·1	101·6	
Stones	2·8	6·6	4·7	5·6	1·1	12·0	10
Fine silt, 0·01–0·005 m.m.	4·7	3·7	3·9	3·7	3·1	4·6	11
,, 0·005–0·002 m.m.	2·0	2·2	2·4	4·3	2·0	2·4	12
Subsoils.							
Fine Gravel, above 1 m.m.	0·3	0·2	0·5	0·5	0·4	0·6	13
Coarse sand, 1–0·2 m.m. ...	8·0	11·3	1·3	18·9	1·6	0·9	14
Fine sand, 0·2–0·04 m.m. ...	31·2	24·8	19·3	24·0	5·0	25·2	15
Silt, 0·04–0·01 m.m. ...	30·8	21·7	20·8	25·4	5·4	25·6	16
Fine silt, 0·01–0·002 m.m.	6·3	7·0	6·0	7·2	3·8	7·7	17
Clay, below 0·002 m.m. ...	14·8	12·1	26·6	17·1	8·3	21·1	18
Moisture	2·5	2·3	4·1	3·1	2·3	3·7	19
Loss on ignition	3·7	5·5	7·3	2·9	6·9	6·1	20
Calcium carbonate ...	1·8	14·9	11·3	0·1	61·3	7·3	21
Total	99·4	99·8	97·2	99·2	95·0	98·2	
Stones	7·4	6·9	7·3	4·9	0·2	9·8	22
Fine silt, 0·01–0·005 m.m.	4·2	4·7	3·7	4·4	2·0	5·7	23
,, 0·005–0·002 m.m.	2·0	2·3	2·3	2·7	1·8	1·9	24
Chemical Analysis.							
Soil.							
Moisture	1·94	2·93	6·76	3·09	3·00	4·51	25
Loss on ignition	4·94	5·06	9·28	3·63	7·20	7·88	26
Nitrogen	0·178	0·194	0·25	0·132	0·331	0·218	27
Alumina, Al_2O_3	3·73	3·60	6·45	4·96	—	5·33	28
Oxide of Iron, Fe_2O_3 ...	2·97	2·44	4·27	2·98	—	3·90	29
Oxide of Manganese, Mn_3O_4	0·087	0·023	0·16	0·054	—	0·057	30
Magnesia, MgO	0·58	0·64	0·69	0·19	—	0·62	31
Lime, CaO....	—	—	—	—	—	—	32
*Carbonates	1·96	3·70	18·1	7·91	49·7	12·2	33
Potash, K_2O	0·48	0·46	0·43	0·35	0·47	0·59	34
†"Available"	0·018	0·015	0·018	0·006	0·009	0·013	35
Phosphoric Acid, P_2O_5 ...	0·101	0·094	0·192	0·143	0·223	0·126	36
†"Available"	0·017	0·012	0·001	0·035	0·001	0·001	37
Sulphuric Acid, SO_3 ...	0·059	0·040	0·089	0·058	—	0·073	38
Subsoil.							
Moisture	2·56	2·35	4·18	3·14	2·37	3·77	39
Loss on ignition	3·74	5·56	7·37	2·93	6·88	6·17	40
Nitrogen	0·115	0·130	0·128	0·074	0·162	0·154	41
*Carbonates	1·88	14·9	11·37	0·084	61·3	7·32	42
Potash, K_2O	0·600	0·435	0·598	0·621	0·510	0·622	43
Phosphoric Acid, P_2O_5 ...	0·073	0·097	0·169	0·117	0·219	0·098	44

* Reckoned as Carbonate of Lime, $CaCO_3$.

† Soluble in 1% Citric Acid.

Chalk.

	Horton Kirby, K.	Fetcham, Sy.	Seale, Sy.	Chilgrove, Sx.	Patching, Sx.	Sadlescombe, Poynings, Sx.		Lewes, Sx.	Eastbourne, Sx.
	252.	59.	29.	213.	266.	263.	270.	269.	253.
1	0·7	1·0	1·0	0·8	3·9	0·7	0·8	1·0	0·5
2	5·6	19·1	8·8	0·7	5·2	0·8	1·2	1·4	0·6
3	36·3	14·8	5·0	21·7	14·5	6·2	10·2	4·3	5·3
4	11·4	5·0	2·0	29·2	20·4	6·0	11·1	4·7	5·5
5	5·7	3·1	3·2	13·9	7·8	3·6	6·3	3·2	5·2
6	15·1	6·4	4·3	12·8	25·5	9·6	17·4	4·6	5·2
7	3·1	2·4	6·8	3·7	4·9	5·8	4·4	2·3	3·5
8	6·1	6·8	5·4	6·8	8·9	6·5	8·2	—	—
9	23·1	39·0	56·9	4·8	1·5	66·0	32·3	65·6	44·0
	107·1	97·6	93·4	94·4	92·6	105·2	91·9	—	—
10	9·5	17·8	0·3	—	21·9	24·3	4·1	8·3	1·4
11	3·4	1·6	1·7	9·4	4·5	2·0	3·4	1·3	2·6
12	2·3	1·5	1·5	4·5	3·2	1·5	2·9	1·9	2·6
13	0·9	—	—	0·9	2·8	0·4	—	1·2	0·4
14	4·9	—	—	0·8	4·0	0·6	—	1·2	0·3
15	35·4	—	—	25·8	14·8	5·4	—	4·9	3·8
16	11·6	—	—	27·3	17·1	6·2	—	3·9	3·2
17	5·4	—	—	10·8	7·0	3·5	—	2·6	3·4
18	16·5	—	—	14·6	33·4	10·0	—	4·1	7·4
19	3·7	—	—	3·1	7·3	5·8	—	1·9	2·0
20	3·6	—	—	6·8	7·7	6·6	—	—	—
21	14·0	—	—	4·2	0·4	55·2	—	54·8	71·6
	96·0	—	—	94·3	94·5	93·7	—	—	—
22	9·6	—	—	—	21·9	27·4	—	6·6	0·1
23	3·3	—	—	5·9	4·7	1·9	—	1·2	1·8
24	2·0	—	—	4·9	2·3	1·5	—	1·4	1·5
25	3·18	2·47	6·81	3·78	5·95	5·80	4·46	2·32	3·54
26	6·12	6·84	5·41	6·86	—	—	8·19	—	—
27	0·244	0·24	0·25	0·330	0·288	0·258	0·291	0·249	0·419
28	3·07	1·86	1·38	5·44	—	—	—	—	1·32
29	3·92	2·04	1·52	2·96	—	—	—	—	2 05
30	0·08	0·132	0·041	0·06	—	—	—	—	Nil.
31	0·48	2·81	0·40	1·00	—	—	—	—	—
32	8·49	—	—	4·66	—	—	—	—	35·33
33	23·12	39·0	56·9	4·8	1·56	66·0	32·3	65·6	44·0
34	0·35	0·30	0·24	0·40	0·26	0·17	0·55	0·10	0·16
35	0·018	0·12	0·005	0·009	0·007	0·002	0·008	0·006	0·010
36	0·224	0·193	0·180	0·169	0·130	0·248	0·239	0·279	0·234
37	0·006	0·003	0·005	0·004	0·007	0·001	0·001	0·002	0·003
38	0·07	0·072	0·13	0·10	—	—	—	—	0·15
39	3·70	—	—	3·18	7·36	5·85	—	1·95	2·04
40	3·65	—	—	5·89	7·76	6·65	—	—	—
41	0·148	—	—	0·204	0·164	0·192	—	0·196	0·180
42	14·0	—	—	4·2	0·44	55·2	—	54·8	71·6
43	0·528	—	—	0·326	0·301	0·243	—	0·188	0·345
44	0·131	—	—	0·126	0·086	0·194	—	0·217	0·150

Upper Greensand.

Locality	Buckland, Sy.	East of Bentley, Hants.	Binsted, Hants.	Treyford (S. Harting), Sx.	Firle, E. Sx.
Number of Analysis	83.	84.	85.	219.	220.
Mechanical Analysis.					
Soil.					
Fine gravel, above 1 m.m.	4·4	5·9	4·2	0·6	0·4
Coarse sand, 1–0·2 m.m.		4·8	2·4	3·3	4·7
Fine sand, 0·2–0·04 m.m.	43·9	26·5	28·4	31·6	23·8
Silt, 0·04–0·01 m.m.	20·0	25·9	28·4	17·3	16·9
Fine silt, 0·01–0·002 m.m.	14·1	12·9	15·9	14·5	10·6
Clay, below 0·002 m.m.	10·1	13·2	13·1	12·3	23·9
Moisture	3·3	3·2	3·9	3·7	5·6
Loss on ignition	4·5	4·6	4·5	7·4	7·1
Calcium carbonate	0·4	0·4	0·04	2·1	0·3
Total	100·7	97·4	100·9	92·8	93·3
Stones	5·4	—	—	0·3	1·4
Fine silt, 0·01–0·005 m.m.	7·3	9·2	11·4	7·1	7·0
„ 0·005–0·002 m.m.	6·8	3·6	4·4	7·3	3·6
Subsoils.					
Fine gravel, above 1 m.m.	1·0	5·5	—	0·2	1·1
Coarse sand, 1–0·2 m.m.	1·7	4·3	—	3·2	4·6
Fine sand, 0·2–0·04 m.m.	41·0	24·2	—	33·9	25·5
Silt, 0·04–0·01 m.m.	18·2	24·1	—	21·3	17·6
Fine silt, 0·01–0·002 m.m.	9·4	15·8	—	13·4	12·6
Clay, below 0·002 m.m.	19·2	18·7	—	16·0	25·3
Moisture	4·3	4·2	—	3·0	5·4
Loss on ignition	2·8	4·0	—	3·6	6·0
Calcium carbonate	3·4	3·4	—	0·2	0·1
Total	101·0	104·2	—	94·8	98·2
Stones	6·1	6·2	—	0·0	8·2
Fine silt, 0·01–0·005 m.m.	6·5	11·5	—	7·6	8·8
„ 0·005–0·002 m.m.	2·9	4·2	—	5·8	3·8
Chemical Analysis.					
Soil.					
Moisture	3·34	3·23	3·99	3·76	5·66
Loss on ignition	4·51	4·60	4·55	7·45	7·15
Nitrogen	0·184	0·186	0·125	0·317	0·261
Alumina, Al_2O_3	—	9·87	2·48	2·39	5·30
Oxide of Iron, Fe_2O_3	2·16	2·25	2·87	1·73	3·72
Oxide of Manganese, Mn_3O_4	0·067	0·123	0·006	0·08	0·05
Magnesia, MgO	0·28	0·38	0·51	0·42	0·60
Lime, CaO	1·29	2·61	0·77	2·35	0·85
*Carbonates	0·40	0·47	0·04	2·10	0·37
Potash, K_2O	0·98	0·60	0·46	0·31	0·50
†"Available"	0·009	0·025	—	0·018	0·015
Phosphoric Acid, P_2O_5	0·112	0·267	0·086	0·098	0·138
†"Available"	0·050	0·162	—	0·020	0·017
Sulphuric Acid, SO_3	0·053	0·056	0·03	0·07	0·05
Subsoil.					
Moisture	4·30	4·22	—	3·05	5·40
Loss on ignition	2·87	4·03	—	3·61	6·03
Nitrogen	0·097	0·116	—	0·131	0·177
*Carbonates	3·41	3·48	—	0·23	0·12
Potash, K_2O	0·99	0·63	—	0·41	0·39
Phosphoric Acid, P_2O_5	0·146	0·149	—	0·075	0·094

* Reckoned as Carbonate of Lime, $CaCO_3$. † Soluble in 1 % Citric Acid.

Gault.

Locality	Brook, K.		Alder Holt, Hants.	N. of Bepton Midhurst, Sx.	Ripe, Sx
Number of Analysis	39.	40.	37.	217.	221.
Mechanical Analysis.					
Soil.					
Fine gravel, above 1 m.m.	0·5	0·3	0·9	0·1	0·3
Coarse sand, 1–0·2 m.m.	10·0	5·2	2·7	17·9	2·9
Fine sand, 0·2–0·004 m.m.	8·5	7·5	20·3	19·3	14·7
Silt, 0·04–0·01 m.m.	15·7	19·3	23·7	21·1	17·4
Fine silt, 0·01–0·002 m.m.	18·2	17·3	15·7	14·0	17·7
Clay below, 0·002 mm.	28·5	30·8	26·7	11·8	27·3
Moisture	5·6	6·8	4·3	4·7	5·6
Loss on ignition	11·6	13·2	7·7	9·0	10·5
Calcium Carbonate	2·5	0·02	0·04	Nil.	0·8
Total	101·1	100·5	102·1	97·9	97·2
Stones	0·2	0·5	2·6	—	—
Fine silt, 0·01–0·005 m.m.	12·5	11·7	9·9	7·5	9·5
„ 0·005–0·002 m.m.	5·6	5·6	5·8	6·4	8·2
Subsoils.					
Fine gravel, above 1 m.m.	—	0·3	0·2	0·0	0·4
Coarse sand, 1–0·2 m.m.	—	4·1	0·7	20·5	1·7
Fine sand, 0·2–0·04 m.m.	—	8·0	22·4	19·8	11·6
Silt, 0·04–0·01 m.m.	—	19·3	17·0	15·0	12·3
Fine silt, 0·01–0·002 m.m.	—	15·2	13·9	9·2	19·1
Clay, below 0·002 m.m.	—	40·3	36·9	25·7	38·8
Moisture	—	4·8	3·7	4·8	5·6
Loss on ignition	—	7·4	6·6	4·4	7·6
Calcium Carbonate	—	0·65	0·16	0·01	0·83
Total	—	100·0	101·6	99·5	97·9
Stones	—	3·8	0·5	—	—
Fine silt, 0·01–0·005 m.m.	—	9·7	8·5	5·4	12·3
„ 0·005–0·002 m.m.	—	5·5	5·3	3·8	6·8
Chemical Analysis.					
Soil.					
Moisture	5·61	6·89	4·37	4·76	5·69
Loss on ignition	11·66	13·21	7·79	9·00	10·56
Nitrogen	0·289	0·221	0·226	0·347	0·314
Alumina, Al_2O_3	6·38	10·07	7·49	5·11	7·88
Oxide of Iron, Fe_2O_3	3·68	3·58	4·42	2·72	4·35
Oxide of Manganese, Mn_3O_4	0·08	0·10	0·07	Traces.	0·05
Magnesia, MgO	0·04	0·07	0·01	0·35	0·51
Lime, CaO	—	—	—	0·46	1·39
*Carbonates	2·52	0·02	0·04	Nil.	0·80
Potash, K_2O	0·90	0·90	0·97	0·34	0·60
†" Available "	0·012	0·012	0·029	0·014	0·011
Phosphoric Acid, P_2O_5	0·133	0·253	0·092	0·059	0·145
†" Available "	0·018	0·039	0·014	0·010	0·010
Sulphuric Acid SO_3	0·036	0·123	0·081	0·07	0·07
Subsoil.					
Moisture	—	4·88	3·74	4·84	5·61
Loss on ignition	—	7·48	6·66	4·42	7·64
Nitrogen	—	0·163	0·112	0·106	0·133
*Carbonates	—	0·65	0·16	0·01	0·83
Potash, K_2O	—	1·04	1·21	0·43	0·41
Phosphoric Acid, P_2O_5	—	0·157	0·072	0 044	0·107

* Reckoned as Carbonate of Lime, $CaCO_3$. † Soluble in 1 % Citric Acid,

Locality	Uncultivated Soils.						
	Hothfield Common, K.		Blackheath, Nr. Chilworth, Sy.	Puttenham, Sy.	Seale, Sy.	Down Park, Nr. Harting, Sx.	
Number of Analysis ...	14.	13.	170.	30.	32.	192.	
Mechanical Analysis.							
Soil.							
Fine gravel, above 1 m.m.	0·1	0·9	1·2	2·8	2·1	0·8	1
Coarse sand, 1–0·2 m.m. ...	68·5	63·3	65·9	56·7	37·7	59·7	2
Fine sand, 0·2–0·04 m.m. ...	18·1	18·0	23·7	24·7	47·6	22·1	3
Silt, 0·04–0·01 m.m. ...	4·3	5·0	2·4	2·9	3·2	3·9	4
Fine silt, 0·01–0·002 m.m....	2·3	4·0	2·0	2·4	2·3	3·8	5
Clay, below 0·002 m.m. ...	0·2	3·1	0·9	0·8	0·7	2·7	6
Moisture	0·9	1·0	0·4	1·5	0·9	1·3	7
Loss on ignition	4·5	3·4	2·6	6·0	4·2	6·4	8
Calcium carbonate... ...	0·04	0·05	Nil.	0·1	Nil.	Nil.	9
Total	99·0	98·8	99·1	97·9	98·7	100·7	
Fine silt, 0·01–0·005 m.m....	2·3	2·3	0·9	1·3	1·4	2·4	10
" 0·005-0·002 m.m.	0·1	1·6	1·0	1·1	0·9	1·4	11
Subsoils.							
Fine gravel, above 1 m.m.	—	—	1·2	—	—	1·6	12
Coarse sand, 1–0·2 m.m. ...	—	—	60·3	—	—	66·7	13
Fine sand, 0·2–0·04 m.m. ...	—	—	24·3	—	—	20·9	14
Silt, 0·04–0·01 m.m. ...	—	—	2·3	—	—	2·9	15
Fine silt, 0·01–0·002 m.m....	—	—	1·7	—	—	3·9	16
Clay, below 0·002 m.m ...	—	—	0·8	—	—	1·5	17
Moisture	—	—	0·4	—	—	0·8	18
Loss on ignition	—	—	2·0	—	—	2·3	19
Calcium carbonate... ...	—	—	0·02	—	—	0·02	20
Total	—	—	93·1	—	—	100·7	
Fine silt, 0·01–0·005 m.m ...	—	—	0·6	—	—	2·5	21
" 0·005–0·002 m.m.	—	—	1·0	—	—	1·4	22
Chemical Analysis.							
Soil.							
Moisture	0·98	1·08	0·48	1·53	0·95	1·36	23
Loss on ignition	4·53	3·49	2·62	6·08	4·21	6·40	24
Nitrogen	0·170	0·105	0·033	0·197	0·145	0·117	25
Alumina, Al_2O_3	Nil.	1·28	Nil.	0·57	0·49	Nil.	26
Oxide of Iron, Fe_2O_3 ...	0·97	1·93	2·24	6·09	3·11	2·38	27
Oxide of Manganese, Mn_3O_4	Nil.	Nil.	Trace.	Nil.	Trace.	Nil.	28
Magnesia, MgO.	0·07	0·14	0·06	0·12	0·09	0·08	29
Lime, CaO	0·34	0·58	0·05	0·22	0·14	0·13	30
*Carbonates	0·04	0·05	Nil.	0·10	Nil.	Nil.	31
Potash, K_2O...	0·093	0·175	0·025	0·043	0·035	0·05	32
†"Available"	0·006	0·012	0·010	0·010	0·010	0·010	33
Phosphoric Acid, P_2O_5 ...	0·047	0·121	0·031	0·080	0·069	0·064	34
†"Available"	0·005	0·033	0·004	0 004	0·004	0·009	35
Sulphuric Acid, SO_3 ...	0·069	0·034	—	0·062	0·034	0·02	36
Subsoil.							
Moisture	—	—	0·48	—	—	0·85	37
Loss on ignition	—	—	2·03	—	—	2·34	38
Nitrogen	—	—	0·026	—	—	0·063	39
*Carbonates	—	—	0·02	—	—	0·02	40
Potash, K_2O	—	—	0·014	—	—	0·067	41
Phosphoric Acid, P_2O_5 ...	—	—	0·044	—	—	0 053	42

* Reckoned as Carbonate of Lime, $CaCO_3$. † Soluble in °/o Citric Acid.

Beds.

	Cultivated Soils.						
	Monks Horton, K.	Nutfield, Sy.		Red Hill, Sy.	Buckland, Sy.	Shalford, Sy.	Eashing (Bargate Rock), Sy.
	78.	101.	102.	126.	82.	124.	203.
1	0·9	2·3	2·9	11·4	2·5	2·5	1·1
2	54·3	42·9	46·6	48·4	45·8	52·6	50·0
3	16·7	27·4	22·9	10·0	17·1	26·2	20·2
4	8·1	6·6	3·5	6·7	9·9	4·8	6·7
5	5·6	5·8	8·8	6·3	7·4	3·5	6·6
6	5·7	7·7	6·9	7·8	12·1	3·8	9·7
7	1·7	1·7	3·6	2·2	1·8	1·1	1·7
8	3·1	4·7	3·6	5·8	3·4	3·3	2·9
9	0·43	0·07	0·21	0·04	0·05	0·3	0·1
	96·5	99·2	99·0	98·7	100·1	98·1	99·0
10	3·0	4·1	6·6	2·8	5·3	2·6	3·7
11	2·5	1·6	2·2	3·5	2·0	0·9	2·9
12	0·3	2·4	—	—	2·7	3·0	1·2
13	57·2	44·9	—	—	40·7	55·7	48·6
14	16·9	21·9	—	—	17·6	23·5	19·6
15	9·1	5·2	—	—	12·3	3·8	8·1
16	4·5	8·4	—	—	8·2	4·9	6·6
17	5·7	11·1	—	—	11·3	4·5	12·3
18	1·6	2·3	—	—	1·7	1·0	2·0
19	2·1	3·2	—	—	2·9	2·2	2·5
20	Nil.	0·11	—	—	0·05	0·1	0·06
	97·4	99·5	—	—	97·5	98·7	101·0
21	2·8	3·3	—	—	5·6	2·4	3·7
22	1·6	5·1	—	—	2·6	2·5	2·8
23	1·74	1·69	3·64	2·21	1·81	1·11	1·73
24	3·17	4·73	3·61	5·87	3·40	3·27	2·85
25	0·117	0·189	0·147	0·196	0·124	0·137	0·104
26	2·54	1·80	1·99	1·49	2·90	1·55	0·70
27	2·36‡	6·61	3·19	2 70	2·12	5·24	5·43
28	Nil.	Nil.	0·02	Nil.	Nil.	0·03	0·04
29	0·12	0·17	0·22	0·19	0·15	0·18	0·21
30	0·72	0·19	0·51	0·73	0·26	0·41	0·29
31	0·43	0·07	0·21	0·04	0·05	0·35	0·10
32	0·382	0·361	0·208	0·181	0·237	0·158	0·275
33	0·018	0·021	0·012	—	0·009	0·007	0·030
34	0·493	0·198	0·158	0·193	0·146	0·191	0·167
35	0·188	0·013	0·040	—	0·048	0·047	0·025
36	0·082	0·042	0·042	0·04	0·063	0·034	0·03
37	1·60	2·32	—	—	1·77	1·06	2 03
38	2·12	3·23	—	—	2·94	2·25	2·58
39	0·052	0·063	—	—	0·086	0 059	0·070
40	Nil.	0·11	—	—	0·05	0·12	0·06
41	0·327	0·507	—	—	0·307	0·144	0·310
42	0·380	0·179	—	—	0·158	0·174	0·183

‡ Much ferrous.

Sandgate Beds.

Locality	Monks Horton, K.	Godington, K.	Repton, K.	Rogate, Sx.
Number of Analysis	79.	73.	122.	222.
Mechanical Analysis.				
Soil.				
Fine gravel, above 1 m.m.	0·5	2·9	2·5	0·5
Coarse sand, 1–0·2 m.m.	4·2	22·0	13·9	14·3
Fine sand, 0·2–0·04 m.m.	31·2	34·1	44·6	27·0
Silt, 0·04–0·01 m.m.	27·0	12·3	14·1	25·5
Fine silt, 0·01–0·002 m.m.	10·9	7·6	6·6	9·9
Clay, below 0·002 m.m.	15·3	9·9	9·5	6·7
Moisture	2·8	2·1	1·7	3·4
Loss on ignition	4·7	5·0	4·0	9·7
Calcium carbonate	0·23	1·4	0·19	0·12
Total	96·5	97·3	97·1	97·1
Stones	—	—	—	—
Fine silt, 0·01–0·005 m.m.	8·1	4·4	5·0	5·4
„ 0·005–0·002 m.m.	2·7	3·2	1·5	4·4
Subsoils.				
Fine gravel, above 1 m.m.	0·4	3·4	—	0·1
Coarse sand, 1–0·2 m.m.	2·2	22·6	—	12·7
Fine sand, 0·2–0·04 m.m.	27·0	33·6	—	24·3
Silt, 0·04–0·01 m.m.	29·0	14·5	—	28·8
Fine silt, 0·01–0·002 m.m.	12·8	6·9	—	7·7
Clay, below 0·002 m.m.	15·2	11·9	—	12·7
Moisture	3·3	2·0	—	2·5
Loss on ignition	4·6	2·9	—	3·9
Calcium carbonate	0·16	0·15	—	0·06
Total	94·7	97·9	—	92·8
Stones	—	—	—	—
Fine silt, 0·01–0·005 m.m.	9·4	4·5	—	4·4
„ 0·005–0·002 m.m.	3·4	2·4	—	3·3
Chemical Analysis.				
Soil.				
Moisture	2·89	2·13	1·79	3·41
Loss on ignition	4·66	5·04	4·01	9·79
Nitrogen	0·137	0·155	0·132	0·363
Alumina, Al_2O_3	5·14	2·70	2·35	2·11
Oxide of iron, Fe_2O_3	3·27	3·14	2·78	2·80
Oxide of Manganese, Mn_3O_4	Nil.	Nil.	Nil.	Trace.
Magnesia, MgO	0·20	0·29	0·22	0·28
Lime, CaO	0·46	1·31	0·60	0·46
*Carbonates	0·23	1·40	0·19	0·12
Potash, K_2O	0·40	0·40	0·28	0·18
†"Available"	0·005	0·008	0·022	0·024
Phosphoric Acid, P_2O_5	0·145	0·158	0·150	0·107
†"Available"	0·027	0·059	0·050	0·014
Sulphuric Acid, SO_3	0·063	0·063	0·06	0·08
Subsoil.				
Moisture	3·33	2·00	—	2·56
Loss on ignition	4·65	2·98	—	3·94
Nitrogen	0·088	0·084	—	0·115
*Carbonates	0·16	0·15	—	0·06
Potash, K_2O	0·398	0·410	—	0·269
Phosphoric Acid, P_2O_5	0·085	0·158	—	0·048

* Reckoned as Carbonate of Lime, $CaCO_3$. † Soluble in 1% Citric Acid.

HYTHE BEDS.

Locality	Aldington, K.	Smeeth, K.	Little Chart, K.	Chart Court, K.	Otham, K.	Sutton Valence, K.	Mereworth, K.		
Number of Analysis ...	149.	93.	72.	167.	187.	185.	128.	128A.	
Mechanical Analysis.									
Soil.									
Fine gravel, above 1 m.m....	0·9	0·8	0·9	1·5	1·4	2·2	5·6	4·9	1
Coarse sand, 1–0·2 m.m. ...	16·8	19·9	30·4	31·0	10·6	7·8	19·7	14·3	2
Fine sand, 0·2–0·04 m.m. ...	28·7	28·8	24·8	27·0	29·4	33·6	30·7	27·8	3
Silt, 0·04–0·01 m.m. ...	9·5	17·0	9·1	6·5	18·7	13·0	13·4	27·0	4
Fine silt, 0·01–0·002 m.m....	9·5	9·0	7·8	8·9	14·0	17·8	8·1	8·9	5
Clay, below 0·002 m.m. ...	18·8	14·6	17·1	13·4	13·7	15·0	13·4	8·2	6
Moisture	3·7	2·5	2·9	2·4	4·3	3·3	2·1	1·7	7
Loss on ignition	6·0	4·5	4·9	2·6	6·4	4·8	4·6	5·1	8
Calcium carbonate ...	3·5	0·41	0·65	0·07	0·46	0·42	0·10	0·1	9
Total...	97·4	97·5	98·6	93·4	98·9	97·9	97·7	98·0	
Stones	—	—	—	—	3·4	6·9	—	—	10
Fine silt, 0·01–0·005 m.m.	6·7	6·0	4·4	4·8	5·5	9·9	6·8	7·2	11
„ 0·005–0·002 m.m.	2·7	2·9	3·3	4·0	8·4	7·9	1·2	1·7	12
Subsoils.									
Fine gravel, above 1 m.m.	0·8	0·3	0·6	—	1·6	1·8	5·3	—	13
Coarse sand, 1–0·2 m.m. ...	17·2	18·1	29·1	—	12·7	6·0	15·7	—	14
Fine sand, 0·2–0·04 m.m. ...	30·7	26·6	22·9	—	29·1	31·8	28·5	—	15
Silt, 0·4–0·01 m.m. ...	11·7	19·4	8·3	—	19·5	13·9	15·9	—	16
Fine silt, 0·01–0·002 m.m.	8·5	9·8	7·8	—	10·1	17·5	8·7	—	17
Clay, below 0·002 m.m. ...	19·9	16·0	18·5	—	16·3	19·5	16·5	—	18
Moisture	3·9	2·7	2·9	—	4·1	3·8	2·7	—	19
Loss on ignition	2·5	3·6	4·2	—	4·2	4·2	4·0	—	20
Calcium carbonate ...	1·24	0·16	0·8	—	0·35	0·2	0·5	—	21
Total	96·2	96·7	95·1	—	97·9	98·7	97·8	—	
Stones	—	—	—	—	3·8	7·4	—	—	22
Fine silt, 0·01–0·005 m.m....	5·3	6·5	3·8	—	4·8	7·9	4·9	—	23
„ 0·005–0·002 m.m.	3·2	3·3	4·0	—	5·2	9·6	3·8	—	24
Chemical Analysis.									
Soil.									
Moisture	3·72	2·49	2·97	2·49	4·37	3·30	2·19	1·76	25
Loss on ignition	6·06	4·47	4·91	2·69	6·39	4·81	4·63	5·17	26
Nitrogen	0·171	0·139	0·142	0·173	0·197	0·156	0·127	0·121	27
Alumina, Al_2O_3	4·27	3·13	3·16	—	3·95	3·08	3·17	1·81	28
Oxide of Iron, Fe_2O_3 ...	4·22	3·06	3·17	—	4·32	4·35	3·44	3·71	29
Oxide of Manganese, Mn_3O_4	0·07	0·06	0·07	—	0·03	Trace.	0·04	0·08	30
Magnesia, MgO	0·41	0·39	0·42	—	0·46	0·47	0·27	0·23	31
Lime, CaO	3·28	0·97	1·94	—	1·54	0·84	0·57	0·16	32
*Carbonates	3·49	0·41	0·65	0·07	0·16	0·42	0·10	0·09	33
Potash, K_2O	0·64	0·37	0·50	0·42	0·51	0·83	0·41	0·17	34
†"Available"	0·019	0·009	0·009	0·04	0·009	0·032	0·019	0·008	35
Phosphoric Acid, P_2O_5 ...	0·144	0·107	0·135	0·182	0·148	0·195	0·146	0·056	36
†"Available"	0·029	0·015	0·031	0·090	0·033	0·073	0·044	0·007	37
Sulphuric Acid, SO_3 ...	0·13	0·034	0·067	—	0·05	0·03	0·04	0·04	38
Subsoil.									
Moisture	3·92	2·78	2·99	—	4·16	3·88	2·74	—	39
Loss on ignition	2·38	3·62	4·68	—	4·27	4·33	4·02	—	40
Nitrogen	0·114	0·100	0·106	—	0·127	0·090	0·073	—	41
*Carbonates	1·24	0·16	0·81	—	0·35	0·20	0·50	—	42
Potash, K_2O	0·57	0·512	0·540	—	0·47	1·07	0·51	—	43
Phosphoric Acid, P_2O_5 ...	0·135	0·086	0·117	—	0·111	0·112	0·112	—	44

* Reckoned as Carbonate of Lime, $CaCO_3$. † Soluble in 1 % Citric Acid.

Beds.

	East Far-leigh, K.	Dibdin, Seven-oaks, K.	Lod-dington, K.	Limps-field, Sy.	Leith Hill, Sy.	Wit-ley, Sy.	Midhurst, Sx. King Ed. VII. Sanatorium.		Sted-ham, Sx.	Ripe, Sx.
	127.	183.	152.	45.	168.	50.	205.	204.	248.	228.
1	2·3	4·8	3·5	6·2	4·2	0·1	2·6	1·4	1·4	0·3
2	9·5	20·3	10·2	27·2	12·7	12·6	9·5	10·1	9·3	6·9
3	30·6	32·3	33·5	22·1	51·6	67·4	67·1	68·8	68·5	42·3
4	19·7	12·1	14·6	14·8	10·9	5·9	5·2	4·7	3·6	19·5
5	11·1	10·4	14·9	10·8	5·5	5·2	6·6	5·7	5·6	6·3
6	13·3	12·6	12·2	11·1	3·4	2·2	5·0	3·6	5·5	11·1
7	2·0	2·8	3·5	2·0	1·5	1·1	1·0	1·8	2·5	2·4
8	5·6	4·4	4·6	2·2	5·8	3·8	3·2	7·8	3·4	4·7
9	1·0	0·3	0·26	0·08	0·07	0·03	0·05	0·03	0·03	0·23
	95·1	100·0	97·3	96·5	95·7	98·3	100·3	104·0	99·9	93·7
10	—	5·9		—	—	—	8·7	9·4	3·3	0·5
11	7·8	5·5	7·6	7·9	4·4	2·7	3·6	3·0	3·1	4·4
12	3·2	4·8	7·2	2·8	1·1	2·5	3·0	2·7	2·5	1·8
13	2·2	3·0	2·6	—	4·8	—	1·1	—	0·4	0·3
14	11·5	15·2	9·8	—	6·0	—	9·6	—	10·0	6·7
15	28·1	38·0	30·2	—	58·5	—	70·1	—	70·4	41·4
16	18·7	13·1	17·5	—	9·2	—	6·1	—	3·5	20·7
17	13·1	10·8	15·5	—	5·7	—	5·9	—	5·2	8·0
18	16·2	13·3	15·3	—	3·2	—	5·4	—	6·1	12·7
19	2·5	2·6	3·8	—	0·8	—	0·8	—	1·9	2·3
20	3·6	2·8	3·3	—	2·7	—	1·4	—	2·1	3·3
21	1·48	0·08	0·35	—	0·05	—	0·04	—	Nil.	0·2
	97·4	98·9	98·4	—	91·0	—	100·5	—	99·6	95·6
22	—	4·3		—	—	—	20·8	—	9·6	Nil.
23	7·8	5·8	7·7	—	4·1	—	3·2	—	3·0	5·9
24	5·3	4·9	7·8	—	1·6	—	2·6	—	2·1	2·1
25	2·03	2·80	3·47	2·04	1·52	1·15	1·06	1·82	2·50	2·47
26	5·63	4·39	4·65	2·22	5·81	3·83	3·26	7·86	3·41	4·79
27	0·187	0·121	0·141	0·035	0·167	0·138	0·117	0·180	0·107	0·175
28	3·58	2·48	2·69	3 05	0·86	0·88	0·82	0·48	0·57	1·67
29	3·55	4·37	3·78	4·49	1·28	1·08	0·90	1·00	1·48	3·19
30	0·05	Nil.	0·06	Nil.	Nil.	Nil.	0·03	Trace	Nil.	0 07
31	0·40	0·40	0·41	0·23	0·13	0·08	0·11	0·08	0·12	0·21
32	2·14	0·56	1·02	0·43	0·21	0·15	0·23	0·08	0·27	0·49
33	1·00	0·30	0·26	0·08	0·07	0·03	0·05	0·03	C·05	0·23
34	0·60	0·71	0·74	0·51	0·12	0·12	0·15	0·134	0·14	0·24
35	0·028	0·031	0·048	0·008	0·015	0·013	0·019	0·009	0·010	0·016
36	0·373	0·187	0·143	0·063	0·059	0·050	0·061	0·037	0·094	0·155
37	0·184	0·070	0·066	0·006	0·013	0·006	0·010	0·003	0·023	0·035
38	0·05	0·03	0·06	0·028	0·04	0·042	0·04	0·04	0·02	0·03
39	2·55	2·64	3·81	—	0·84	—	0·87	—	1·98	2·37
40	3·65	2·86	3·29	—	2·70	—	1·45	—	2·11	3·29
41	0·092	0·085	0·097	—	0·058	—	0·064	—	0·067	0·088
42	1·48	0·08	0·35	—	0·05	—	0·04	—	Nil.	0·20
43	0·31	0·625	0·87	—	0·08	—	0·15	—	0·118	0·421
44	0·22	0·109	0·091	—	0·045	—	0·038	—	0·071	0·221

Locality	Wood-church, K.	Bethers-den, K.	Sutton Val-ence, K.	Lingfield, Sy.		Woodchurch, K.		Bidden-den, K.	Shad-dox-hurst, K.	
Number of Analysis ...	70.	287.	43.	97.	98.	69.	71.	257.	267.	
Mechanical Analysis.										
Soil.										
Fine gravel, above 1 m.m.	0·9	0·8	2·0	0·2	0·2	0·5	0·5	0·3	0·2	*1*
Coarse sand, 1–0·2 m.m. ...	1·1	1·5	3·6	3·6	7·0	2·5	1·6	1·5	1·5	*2*
Fine sand, 0·2–0·04 m.m.	9·3	8·7	10·6	8·5	5·6	14·7	10·1	20·2	11·0	*3*
Silt, 0·04–0·01 m.m. ...	25·9	13·7	12·8	27·5	14·4	24·2	33·3	22·2	19·6	*4*
Fine silt, 0·01–0·002 m.m.	24·4	31·6	22·0	25·9	22·7	23·7	27·4	20·1	26·8	*5*
Clay, below 0·002 m.m. ...	28·6	27·8	33·8	29·2	29·3	20·1	21·5	20·3	22·1	*6*
Moisture	4·0	4·8	6·0	4·1	8·7	2·2	2·6	5·0	4·8	*7*
Loss on ignition	8·7	9·2	10·5	6·3	11·1	4·7	5·6	5·2	9·8	*8*
Calcium carbonate ...	0·08	0·8	1·7	0·2	0·02	3·8	0·03	Trace.	0·16	*9*
Total	103·0	98·9	103·0	105·5	99·1	96·4	102·7	94·8	96·0	
Stones	0·6	0·5	3·0	0·1	0·2	1·1	0·1	—	—	*10*
Fine silt, 0·01–0·005 m.m.	17·8	23·7	12·6	18·0	16·0	16·3	17·8	13·5	16·0	*11*
,, 0·005–0·002 m.m.	6·6	7·8	9·3	7·9	6·7	7·4	9·6	6·5	10·8	*12*
Subsoils.										
Fine gravel, above 1 m.m.	0·7	—	—	0·1	1·2	0·6	—	1·5	0·3	*13*
Coarse sand, 1–0·2 m.m. ...	1·1	—	—	0·7	10·0	1·9	—	2·3	1·6	*14*
Fine sand, 0·2–0·04 m.m.	9 0	—	—	2·6	6·5	13·0	—	20·1	8·5	*15*
Silt, 0·04–0·01 m.m. ...	18·8	—	—	8·9	15·7	27·8	—	24·4	25·1	*16*
Fine silt, 0·01–0·002 m.m.	26·5	—	—	20·5	20·4	23·3	—	16·4	24·8	*17*
Clay, below 0·002 m.m. ...	37·8	—	—	48·6	32·9	28·9	—	23·2	26·7	*18*
Moisture	3·6	—	—	5·4	3·4	3·1	—	3·5	3·4	*19*
Loss on ignition	5·3	—	—	6·5	6·5	4·0	—	2·8	2·6	*20*
Calcium carbonate ...	0·03	—	—	0·07	0·04	0·05	—	Trace.	Trace.	*21*
Total	102·9	—	—	93·4	96·7	102·7	—	94·2	93·0	
Stones	0·1	—	—	—	1·7	0·4	—	—	—	*22*
Fine silt, 0·01–0·005 m.m.	18·5	—	—	11·6	13·1	16·7	—	11·6	17·5	*23*
,, 0·005–0·002 m.m.	7·9	—	—	7·0	7·3	6·6	—	4·7	7·3	*24*
Chemical Analysis.										
Soil.										
Moisture	4·07	4·87	6·09	4·17	8·76	2·24	2·68	5·05	4·87	*25*
Loss on ignition	8·73	9·24	10·57	6·36	11·17	4·72	5·68	5·20	9·80	*26*
Nitrogen	0·261	0·190	0·327	0·166	0·291	0·134	0·149	0·274	0·310	*27*
Alumina, Al_2O_3	6·45	8·60	10·45	5·72	5·34	7·18	5·02	4·19	—	*28*
Oxide of Iron, Fe_2O_3 ...	8·81	6·33‡	5·90	5·82	4·47	3·56	4·93	4·49	—	*29*
Oxide of Manganese, Mn_3O_4	0·08	0·02	0·03	0·09	Nil.	0·09	0·05	Traces.	—	*30*
Magnesia, MgO	0·31	0·29	0·55	0·38	0·39	0·68	0·30	—	—	*31*
Lime, CaO	0·70	1·19	2·11	0·88	0·56	2·71	0·37	0·39	—	*32*
*Carbonates	0·08	0·84	1·76	0·20	0·02	3·82	0·03	Trace.	0·16	*33*
Potash, K_2O	0·61	0·37	0·76	0·56	0·33	0·44	0·52	0·52	0·46	*34*
†" Available "	0·012	0·011	0·014	0·010	0·012	0·060	0·018	0·010	0·006	*35*
Phosphoric Acid, P_2O_5 ...	0·125	0·176	0·180	0·078	0·139	0·114	0·099	0·085	0·104	*36*
†" Available "	0·004	0·014	0·014	0·002	0·006	0·012	0·003	0·002	0·003	*37*
Sulphuric Acid, SO_3 ...	0·084	0 06	0·138	0·04	0·07	—	0·03	0·03	—	*38*
Subsoil.										
Moisture	3·62	—	—	5·49	3·45	3·18	—	3·55	3·46	*39*
Loss on ignition	5·37	—	—	6·50	6·50	4·04	—	2·80	2·59	*40*
Nitrogen	0·123	—	—	0·074	0·108	0·075	—	0·097	0·129	*41*
*Carbonates	0·03	—	—	0·070	0·04	0·05	—	Trace.	54·8	*42*
Potash, K_2O	1·111	—	—	1·20	0·654	—	—	0·41	0·229	*43*
Phosphoric Acid, P_2O_5 ...	0·088	—	—	0·05	0·055	—	—	0·032	0·036	*44*

* Reckoned as Carbonate of Lime. $CaCO_3$. † Soluble in 1% Citric Acid,

Clays.

	East Sutton, K.	Staplehurst, K.	Marden, K.	Cranleigh, Sy.	Lower Dicker, Sx.	Penshurst, K.	Cranleigh, Sy.			Witley, Sy.	North Chapel, Sx.	Billingshurst, Sx.	Horsham Stone, near Christ's Hospital, Horsham, Sx.
	692.	86.	74.	52.	255.	75.	53.	54.	55.	51.	196.	215.	232.
1	1·3	0·1	1·0	0·2	1·0	2·0	2·9	0·1	1·3	12·4 (1–2)	0·9	1·8	0·9
2	2·1	2·4	1·9	1·7	2·0	9·6	14·8	21·5	11·9		11·4	6·6	7·6
3	19·4	12·3	10·8	6·0	26·6	15·2	23·6	39·2	20·2	28·5	43·2	33·8	34·0
4	20·5	23·2	20·7	29·8	23·0	32·2	21·5	18·0	30·3	18·5	13·0	20·3	15·5
5	25·9	23·8	28·6	35·8	17·8	16·6	19·7	12·0	18·0	15·7	10·2	8·2	15·8
6	19·4	23·9	20·7	22·1	17·9	11·8	14·2	8·4	13·1	10·7	10·9	13·0	14·3
7	3·8	2·7	2·4	4·6	2·6	2·0	4·4	2·2	2·3	4·7	2·0	2·3	2·9
8	6·2	7·2	6·1	5·7	6·2	7·8	5·0	2·7	3·5	6·5	5·1	5·2	6·5
9	0·01	0·04	0·64	0·04	0·7	0·03	0·05	0·07	0·05	—	0·8	0·4	0·09
	98·6	95·7	92·8	106·0	97·8	97·3	106·2	101·2	100·7	97·0	97·5	91·6	97·6
10	1·8	0·1	0·5	0·9	—	15·0	6·1	1·0	3·8	5·5	0·6	0·8	0·4
11	18·8	18·5	23·2	23·7	13·2	12·6	12·9	6·7	11·3	8·7	7·9	2·3	12·4
12	7·0	5·2	5·4	12·1	4·6	4·0	6·7	5·2	6·7	7·0	2·2	5·9	3·3
13	—	1·3	4·7 (13–14)	—	0·6	4·8	—	—	—	—	0·6	1·6	1·0
14	—	4·6		—	1·1	13·1	—	—	—	—	21·4	6·3	9·7
15	—	25·6	11·0	—	23·2	23·5	—	—	—	—	34·2	27·7	34·1
16	—	32·1	19·6	—	15·1	29·8	—	—	—	—	10·6	23·2	15·0
17	—	14·6	28·3	—	21·9	8·9	—	—	—	—	10·4	14·2	14·6
18	—	15·4	23·3	—	25·7	11·9	—	—	—	—	14·0	18·7	16·5
19	—	2·0	3·1	—	3·3	2·1	—	—	—	—	1·7	2·6	2·4
20	—	4·8	3·7	—	5·5	3·4	—	—	—	—	3·5	3·8	4·0
21	—	Trace.	0·18	—	0·2	0·05	—	—	—	—	0·06	0·2	0·16
	—	100·4	93·9	—	96·6	97·6	—	—	—	—	96·5	98·3	97·5
22	—	0·2	0·0	—	—	45·	—	—	—	—	1·0	0·6	4·6
23	—	10·0	20·3	—	15·3	4·4	—	—	—	—	7·2	9·6	10·6
24	—	4·5	8·0	—	6·6	4·5	—	—	—	—	3·1	4·5	4·0
25	3·81	2·73	2·40	4·63	2·67	2·02	4·41	2·29	2·38	4·74	2·00	2·37	2·90
26	6·24	7·28	6·11	5·74	6·23	7·87	5·02	2·79	3·59	6·59	5·10	5·21	6·58
27	0·187	0·224	0·181	0·171	0·143	0·249	0·150	0·103	—	0·205	0·145	0·157	0·226
28	5·68	4·00	4·68	5·42	4·37	5·33	3·57	1·88	3·23	—	3·18	5·63	2·50
29	3·98	4·57	3·92	3·75	§4·22	2·83	4·69	3·62	3·49	4·37	3·40	3·00	3·79
30	0·06	0·09	0·03	0·17	0·13	0·03	0·12	0·01	0·12	—	0·03	0·03	0·01
31	0·26	0·20	0·37	0·26	0·27	0·23	0·21	0·17	0·21	—	0·12	0·18	0·32
32	0·46	0·49	0·99	0·34	0·89	0·36	0·54	0·42	0·48	—	0·43	0·82	0·43
33	0·01	0·04	0·64	0·04	0·70	0·03	0·05	0·07	0·05	—	0·79	0·45	0·09
34	0·51	0·38	0·35	0·47	0·41	0·18	0·22	0·18	0·25	—	0·30	0·32	0·29
35	0·023	0·091	0·006	0·013	0·006	0·013	0·012	0·007	0·008	—	0·006	0·007	0·010
36	0·054	0·116	0·111	0·082	0·089	0·102	0·084	0·081	0·087	0·096	0·092	0·085	0·087
37	0·006	0·005	0·009	0·004	0·002	0·007	0·003	0·003	0·006	—	0·006	0·006	0·006
38	0·05	0·085	0·061	0·04	0·04	0·086	0·03	0·03	0·04	—	0·04	0·05	0·05
39	—	2·01	3·16	—	3·31	2·16	—	—	—	—	1·76	2·66	2·49
40	—	4·80	3·78	—	5·50	3·45	—	—	—	—	3·47	3·86	4·02
41	—	0·141	0·089	—	0·104	0·085	—	—	—	—	0·076	0·078	0·100
42	—	0·01	0·18	—	0·20	0·05	—	—	—	—	0·06	0·20	0·16
43	—	0·311	0·30	—	0·451	0·468	—	—	—	—	0·338	0·374	0·52
44	—	0·086	0·051	—	0·061	0·088	—	—	—	—	0·093	0·057	0·052

‡ Much ferrous. § Slight ferrous.

Lower Wealden Strata.

	Ashdown Beds.			Tunbridge Wells Beds.				Wadhurst Clay.		
Locality	Forest Ridge, Sx.	Wych Cross, Sx.	Hart-field, Sx.	Great-ham	Groom-bridge.	Ew-hurst, Sx.	Sedles-combe.	Ash-hurst.	Ew-hurst, Sx.	Rol-venden Sx.
Number of Analysis ...	197.	241.	244.	246.	242.	289.	250.	239.	172.	179.
Mechanical Analysis.										
Soil.										
Fine gravel, above 1 m.m.	0·8	0·2	3·5	1·6	1·1	1·8	9·3	1·1	2·9	0·4
Coarse sand, 1–0·2 m.m. ...	0·3	0·3	0·8	5·0	0·8	3·3	3·9	0·4	1·8	0·5
Fine sand, 0·2–0·04 m.m.	35·2	53·2	25·3	27·4	47·3	36·8	27·8	35·9	13·2	24·7
Silt, 0·04–0·01 m.m. ...	35·2	19·9	27·1	33·8	18·6	20·9	29·6	21·6	20·4	30·1
Fine silt, 0·01–0·002 m.m.	15·3	10·1	21·5	14·3	12·4	14·3	8·2	15·0	22·4	19·7
Clay, below 0·002 m.m. ...	5·4	5·9	12·5	9·7	12·4	13·5	12·5	15·7	25·1	14·9
Moisture	1·8	2·1	2·1	1·8	2·0	1·6	2·3	2·3	3·6	1·8
Loss on ignition	5·9	7·0	5·0	4·6	4·1	4·4	3·8	4·9	7·7	5·9
Calcium carbonate ...	Nil.	0·05	0·2	0·9	0·07	0·29	2·6	0·26	0·14	0·1
Total	100·4	98·8	98·0	99·1	98·8	96·9	100·0	97·2	97·2	98·1
Stones	—	—	—	—	—	—	—	—	15·5	—
Fine silt, 0·01–0·005 m.m.	12·7	7·6	16·9	10·9	8·1	9·6	6·9	11·1	6·8	14·1
„ 0·005–0·002 m.m.	3·1	2·5	4·6	3·3	4·2	4·6	1·3	3·9	—	5·6
Subsoils.										
Fine gravel, above 1 m.m.	—	—	2·0	3·9	2·0	2·5	12·3	0·2	2·9	0·3
Coarse sand, 1–0·2 m.m. ...	—	—	0·9	4·7	0·4	2·8	4·6	0·0	1 2	0·1
Fine sand, 0·2–0·04 m.m.	—	—	23·9	23·2	46·2	35·2	24·4	39·4	11·8	18·0
Silt, 0·04–0·01 m.m. ...	—	—	27·1	34·0	16·3	19·9	28·4	19·7	26·8	34·3
Fine silt, 0·01–0·002 m.m.	—	—	20·6	15·9	10·6	16·1	9·7	12 5	16·2	22·3
Clay, below 0·002 m.m. ...	—	—	17·3	11·1	16·6	16·1	13·4	21·2	22·8	17·0
Moisture	—	—	2·2	1·7	2·4	1·5	1·5	2·1	3·9	2·0
Loss on ignition	—	—	4·2	3·3	3·7	4·1	4·1	3·6	6·3	4·4
Calcium carbonate ...	—	—	0·15	0·2	0·29	0·33	2·7	0·09	0·13	0·1
Total	—	—	98·3	98·0	98·5	98·5	101·1	98·8	92·0	98·5
Stones	—	—	—	—	—	—	—	—	—	—
Fine silt, 0·01–0·005 m.m.	—	—	15·6	12·6	7·3	10·9	7·9	8·8	9·5	15·0
„ 0·005–0.002 m.m.	—	—	5·0	3·2	3·2	5·2	1·8	3·6	6·7	7·3
Chemical Analysis.										
Soil.										
Moisture	1·87	2·16	2·16	1·86	2·04	1·59	2·38	2·38	3·67	1·82
Loss on ignition	5·94	7 00	5·12	4·69	4·13	4·46	3·77	4·96	7·76	5·98
Nitrogen	0·130	0·195	0·142	0·133	0·128	0·109	0·167	0·147	0·176	0·182
Alumina, Al_2O_3	0·17	0·90	1·66	2·38	1·31	—	1·95	2·95	4·75	4·26
Oxide of iron, Fe_2O_3 ...	1·13	0·81	3·35	3·47	3·71	—	8·93	3·60	5·34	3·57
Oxide of Manganese, Mn_3O_4	Nil.	Nil.	0·13	0·03	0·12	—	0·06	Nil.	Trace.	0·03
Magnesia, MgO	0 08	0·07	0·16	0·15	0·13	—	0·17	0·24	0·31	0·24
Lime, CaO	0·21	0·22	0·38	0·94	0·30	—	0·26	0·68	0·93	0·34
*Carbonates	Nil.	0·05	0·21	0·90	0·07	0·29	2·66	0·26	0·14	0·09
Potash, K_2O	0·03	0·067	0·155	0·209	0·179	0·135	0·136	0 26	0·41	0·49
†"Available"	0·017	0·010	0·013	0·012	0 009	0·014	0·009	0·010	0.009	0·074
Phosphoric Acid, P_2O_5 ...	0·019	0·035	0·082	0·101	0·116	0·079	0·182	0·106	0·169	0·256
†"Available"	0·003	0·004	0·007	0·012	0·013	0·009	0 014	0·007	0·031	0·082
Sulphuric Acid, SO_3 ...	0·02	0·05	0·04	0·05	0·04	—	0·03	0·04	0·04	0·06
Subsoil.										
Moisture	—	—	2·24	1·78	2·45	1·47	1·51	2·11	3·98	2·05
Loss on ignition	—	—	4·28	3·32	3·74	4·14	4·09	3·66	6·36	4·48
Nitrogen	—	—	0·098	0·087	0·112	0·073	0·082	0·066	0·110	0·116
*Carbonates	—	—	0·15	0·21	0·29	0·33	2·70	0 09	0·13	0·11
Potash, K_2O	—	—	0·463	0·299	0·558	0·14	0·303	0·423	0·78	0·57
Phosphoric Acid, P_2O_5 ...	—	—	0·059	0·07	0·110	0·051	0·134	0·049	0·147	0·097

* Reckoned as Carbonate of Lime, $CaCO_3$.

† Soluble in 1 % Citric Acid.

INDEX TO NUMBERS OF SOILS.

Number.	Formation.	Locality.
7	Chalk	Wye, Kent.
13 & 14	Folkestone beds	Hothfield Common, Kent.
26	London clay	Wanborough, Surrey.
29	Chalk	Seale, Surrey.
30	Folkestone beds	Puttenham Common, Surrey.
32	Folkestone beds	Seale, Surrey.
37	Gault	Alder Holt, Binsted, Hants.
39	Gault	Brook, Kent.
40	Gault	" "
43	Weald clay	Below Sutton Valence, Kent,
45	Hythe beds	Limpsfield, Kent.
50	Hythe beds	Witley, Surrey.
51	Weald clay	" "
52	Weald clay	Cranleigh, Kent.
53	Weald clay	" "
54	Weald clay	" "
55	Weald clay	" "
57	London clay	Ashtead Common, Surrey.
59	Chalk	Fetcham, Surrey.
61	Chalk	Minster, Thanet, Kent.
62	Chalk	" "
63	Thanet beds	Chislet, Kent.
64	Thanet beds	Teynham, Kent.
65	London clay	Whitstable, Kent.
66	Chalk	Sutton by Dover, Kent.
67	London clay	Eastchurch, Sheppey, Kent.
68	Chalk	Meopham, Kent.
69	Weald clay	Woodchurch, Kent.
70	Weald clay	" "
71	Weald clay	" "
72	Hythe beds	Little Chart, Kent.
73	Sandgate beds	Godington, Kent.
74	Weald clay	Marden, Kent.
75	Weald clay	Between Hildenborough and Penshurst, Kent.
76	London clay	Hayes Common, Kent.
77	London clay	Langley Park, West Wickham, Kent.
78	Folkestone beds	Monks Horton, Kent.
79	Sandgate beds	" "
80	London clay	Woodnesboro., Kent.
81	Thanet beds	Selling Kent.
82	Folkestone beds	Buckland, Surrey.
83	Upper greensand ...	" "
84	Upper greensand ...	Bentley, Hampshire.
85	Upper greensand ...	Binsted, Hampshire.
86	Weald clay	Staplehurst, Kent.
87	Bagshot, Lower	Horsell, Surrey.
88	Bagshot, Lower	Wisley, Surrey.
89	Bagshot, Middle	Windlesham, Surrey.
90	Bagshot, Middle	Bisley, Surrey.
91	Bagshot, Upper	Brookwood, Surrey.
93	Hythe beds	Smeeth, Kent.
95	Thanet beds	Hoath, Kent.
96	Woolwich beds	Walmstone, Kent.
97	Weald clay	Lingfield, Surrey.
98	Weald clay	" "

Number.	Formation.	Locality.
100	Brick earth	Wye, Kent.
101	Folkestone beds	Nutfield, Surrey.
102	Folkestone beds	" "
103	Alluvial	" "
104	Bagshot beds	Claygate, Surrey.
105	London clay	Chessington, Surrey.
106	Bagshot beds	Tolworth, Surrey.
107	London clay	" "
108	Clay-with-Flints	Kenley, Surrey.
109	Clay-with-Flints	Hamsey Green, Surrey
110	Clay-with-Flints	" "
111	Clay-with-Flints	Coalsden, Surrey.
112	Brick earth	Stourmouth, Kent.
117*a*	Thanet beds	Newington, Kent.
117*b*	Thanet beds	" "
118	Thanet beds	Barton, Westmarsh, Kent
119	Thanet beds	Wickham, Kent.
120	Brick earth	" "
122	Sandgate beds	Repton, Kent.
124	Hythe beds	Shalford, Surrey.
126	Folkestone beds	Redhill, Surrey.
127	Hythe beds	East Farley, Kent.
128	Hythe beds	Mereworth, Kent.
128*a*	Hythe beds	" "
129	Brick earth	Ickham, Kent.
131	Clay-with-Flints	Meopham, Kent.
132	Clay-with-Flints	Rainham, Kent.
133	Brick earth	Teynham, Kent.
135	Clay-with-Flints	Rainham, Kent.
137	Clay-with-Flints	Molash, Kent.
140	Alluvial	Yalding, Kent.
143	Alluvial	Orgarswick, Kent.
145	Alluvial	Worth, Kent.
147	Alluvial	Stonar, Kent.
149	Hythe beds	Aldington, Kent.
152	Hythe beds	Loddington, Kent.
153	Clay-with-Flints	Waltham, Kent.
155	Clay-with-Flints	Elham, Kent.
157	Clay-with-Flints	Elham Park, Kent.
159	Clay-with-Flints	Stelling Minnis, Kent.
161	Alluvial	Graveney Marshes, Kent.
167	Hythe beds	Chart Court, Kent.
168	Hythe beds	Leith Hill, Surrey.
170	Folkestone beds	Blackheath, near Chilworth, Surrey.
172	Wadhurst clay	Ewhurst, Sussex.
174	Alluvial	" "
177	Alluvial	St. Mary Hoo, Kent.
179	Wadhurst clay	Rolvenden, Sussex.
180	Clay-with-Flints	Loyterton, Kent.
181	Thanet beds	Between Swanley and Foots Cray, Kent.
183	Hythe beds	Between Whitley and Dibden, Kent.
185	Hythe beds	Between Sutton Valence and E. Sutton, Kent.
187	Hythe beds	North of Otham, Kent.
189	Alluvial	Weybridge, Surrey.
192	Folkestone beds	Down Park, near Rogate, Sussex.
193	Thanet beds	Newington, Kent.
196	Weald clay	North Chapel, Sussex.
197	Ashdown beds	Forest Ridge, Sussex.
198	Alluvial	Lydd, Kent.

Number.	Formation.	Locality.
200	Alluvial	Lydd, Kent.
203	Bargate rock	Bargate, Surrey.
204	Hythe beds	King Edward VII. Sanatorium, Midhurst, Sussex.
205	Hythe beds	Midhurst, Sussex.
207	Brick earth	Shopwyke, Sussex.
209	Brick earth	Yapton, Sussex.
211	Brick earth	Oving, Sussex.
213	Chalk	Chilgrove, Sussex.
215	Weald clay	Billingshurst, Sussex.
217	Gault	North of Bepton, Sussex.
219	Upper greensand... ...	Treyford, Sussex.
220	Upper greensand... ...	Firle, Sussex.
221	Gault	Ripe, Sussex.
222	Sandgate beds	Nr. Rogate, Sussex.
225	Alluvial	Lydd, Kent.
226	Alluvial	Orgarswick, Kent.
228	Hythe beds	Ripe, Sussex.
230	Brick earth	Rainham, Kent.
232	Horsham stone	Nr. Christ's Hospital, Sussex.
236	Alluvial	Orgarswick, Kent.
239	Wadhurst clay	Ashhurst, Sussex.
241	Ashdown beds	Wych Cross, Sussex.
242	Tunbridge Wells beds ...	1 Mile North of Groombridge, Sussex.
244	Ashdown beds	Hartfield, Sussex.
246	Tunbridge Wells beds ...	Greatham, Sussex.
248	Hythe beds	Stedham, Sussex.
250	Tunbridge Wells beds ...	Sedlescombe, Sussex.
252	Chalk	Horton Kirby, Kent.
253	Chalk	Eastbourne, Sussex.
255	Weald clay	Lower Dicker, Sussex.
257	Weald clay	Biddenden, Kent.
261	Chalk	Lenham, Kent.
263	Chalk	Sadlescombe, Poynings, Sussex.
266	Chalk	Patching, Sussex.
267	Weald clay	Shaddoxhurst, Kent.
269	Chalk	Lewes, Sussex.
270	Chalk	Sadlescombe, Poynings, Sussex.
272	Alluvial	Beddingham, Sussex.
273	Alluvial	Midley, Kent.
275	Alluvial	Hope-all-Saints, Kent.
277	Alluvial	Richborough, Kent.
279	Alluvial	Chislet, Kent.
281	Alluvial	Hope-all-saints, Kent.
283	Alluvial	Midley, Kent.
285	Alluvial	Ewhurst, Sussex.
287	Weald clay	Bethersden, Kent.
288	Alluvial	West Ham, Sussex.
289	Wadhurst clay	Ewhurst, Sussex.
290	London clay	Merton, Surrey.
291	London clay	,, ,,
292	London clay	,, ,,
293	London clay	,, ,,
294	London clay	,, ,,
295	Alluvial	,, ,,
296	Alluvial	,, ,,
297	Alluvial	,, ,,
659	Thanet beds	Greenhithe, Kent.
678	Thanet beds	Goldstone, Sandwich, Kent
692	Weald clay	East Sutton, Kent.

APPENDIX.

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The literature dealing with Kent, Surrey, and Sussex is very extensive, and references to the agriculture are extremely numerous. In the subjoined list a few of the more important works only are included:—

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Boys. General view of the Agriculture of Kent, 1813.

Stevenson. General view of the Agriculture of Surrey, 1813.

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Mockett, John. Mockett's Journal, 1836.

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Among the numerous papers that have been published dealing with the agriculture of the counties may be mentioned:—

Buckland, G. Farming of Kent, Journal of the Royal Agricultural Society, 1846, vol. 6, p. 251.

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Way, J. T., and Paine, J. M. The Chemical and Agricultural Characters of the Chalk Formation, *ibid.*, 1851, vol. 12, p. 544.

Topley, William. Agricultural Geology of the Weald, *ibid.*, 1872, 2nd Series, vol. 8, p. 241.

Whitehead, Charles. Fruit growing in Kent, *ibid.*, 1877, 2nd Series, vol. 13, p. 92, and 1889, vol. 25, p. 156.

Sketch of the Agriculture of Kent, *ibid.*, 1899, 3rd Series, vol. 10, p. 429.

Dunstan, M. J. R. Kent or Romney Marsh Sheep, Journal of the Board of Agriculture, 1907, vol. 14, p. 75.

Rigden, Henry. Sussex Cattle, Journal of the Royal Agricultural Society, 1908, vol. 69, p. 114.

Experiments to improve the agriculture of the counties were made in Sussex by the Earl of Egremont at the end of the 18th century (*see* above), from 1881 to 1886 by the Sussex Association for the Improvement of Agriculture, and in the present time by the Staff of the Agricultural College, Uckfield; in Kent and Surrey experiments have been carried out by the Staff of the South-Eastern Agricultural College, Wye.

2350

INDEX.

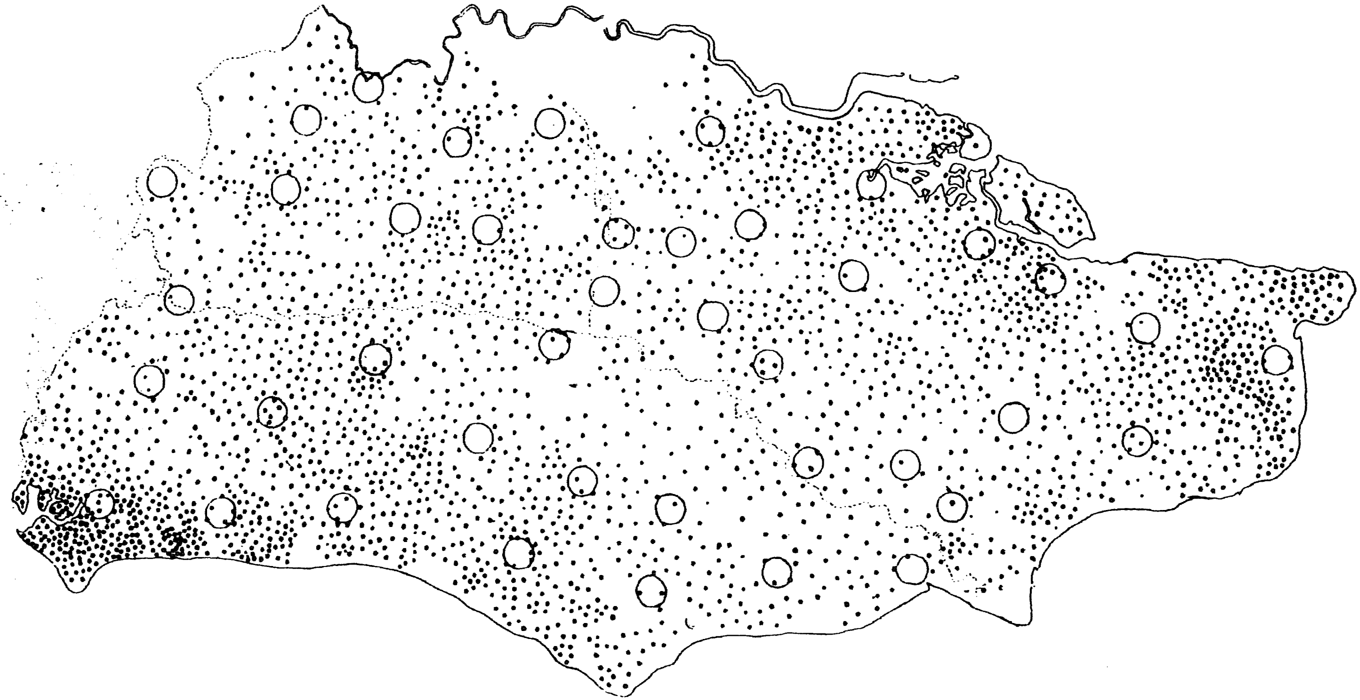

FIG. 42.—MAP SHOWING DISTRIBUTION OF ARABLE LAND.
Each dot represents 200 acres.
(The circles indicate the locality of certain market towns, &c.)

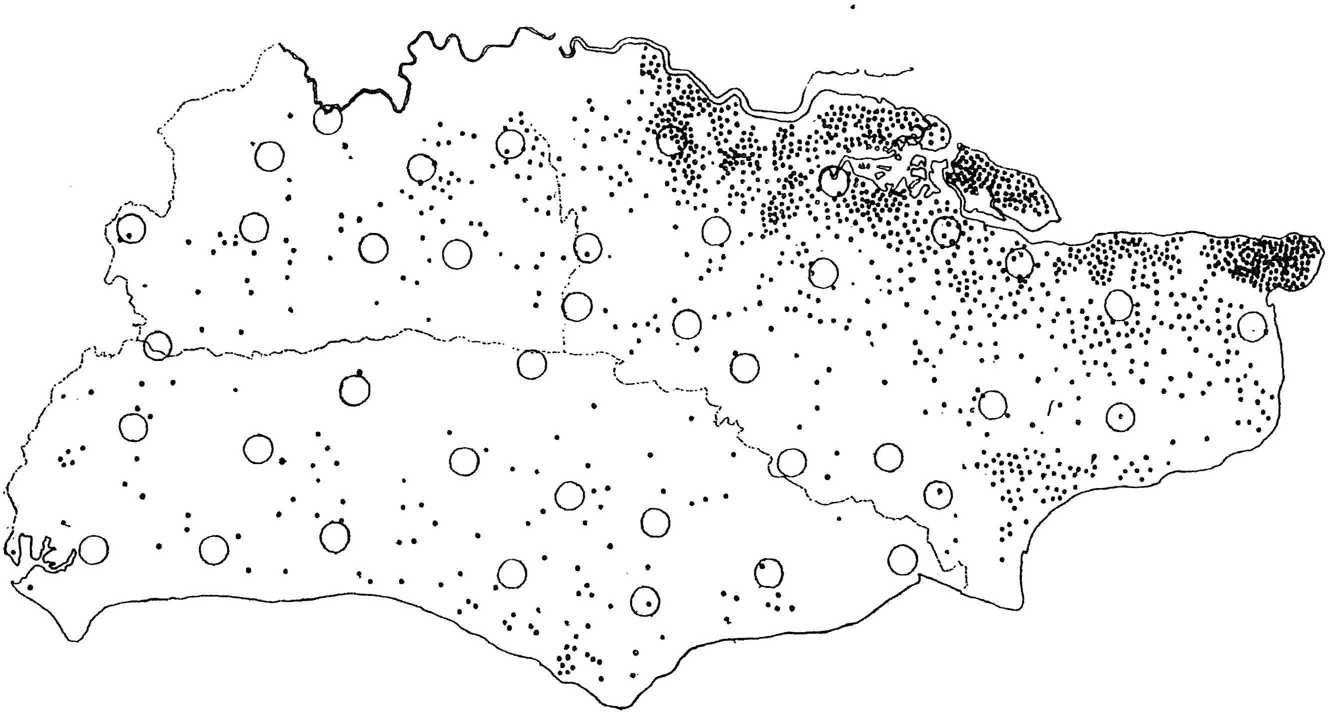

FIG. 43.—MAP SHOWING DISTRIBUTION OF LUCERNE
Each dot represents 10 acres.

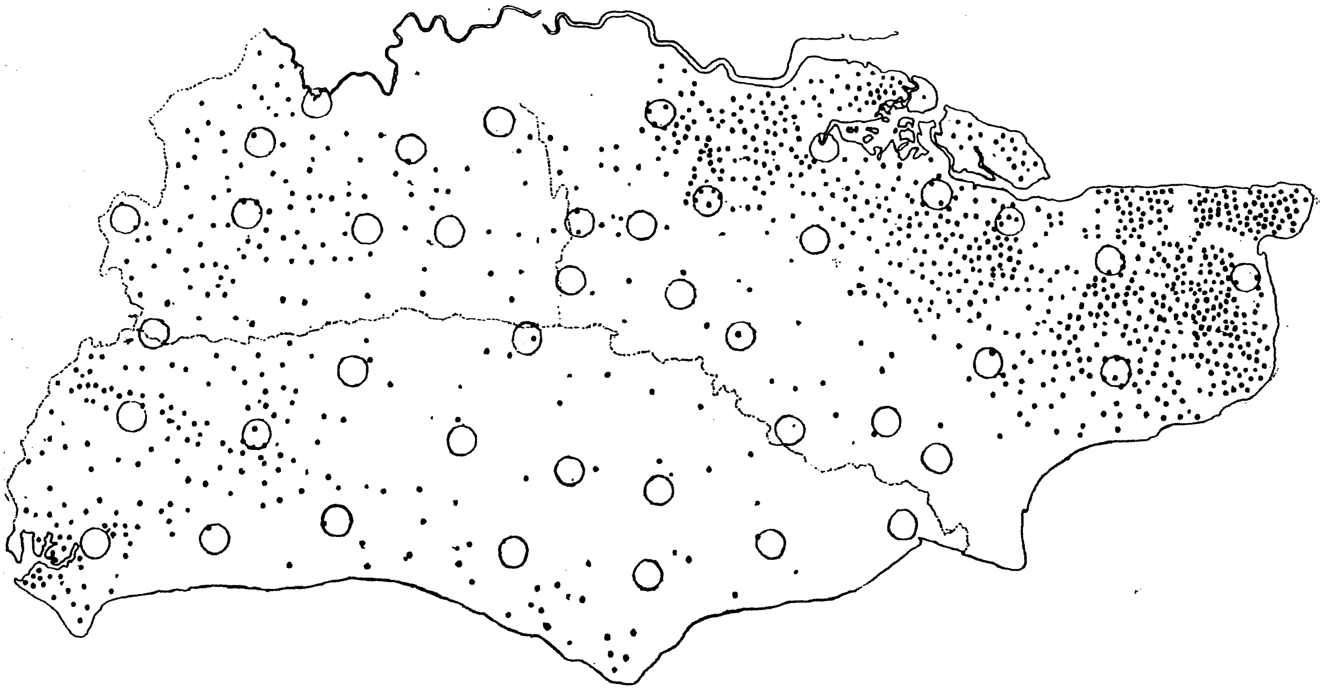

FIG. 44.—MAP SHOWING DISTRIBUTION OF BARLEY.
Each dot represents 40 acres.

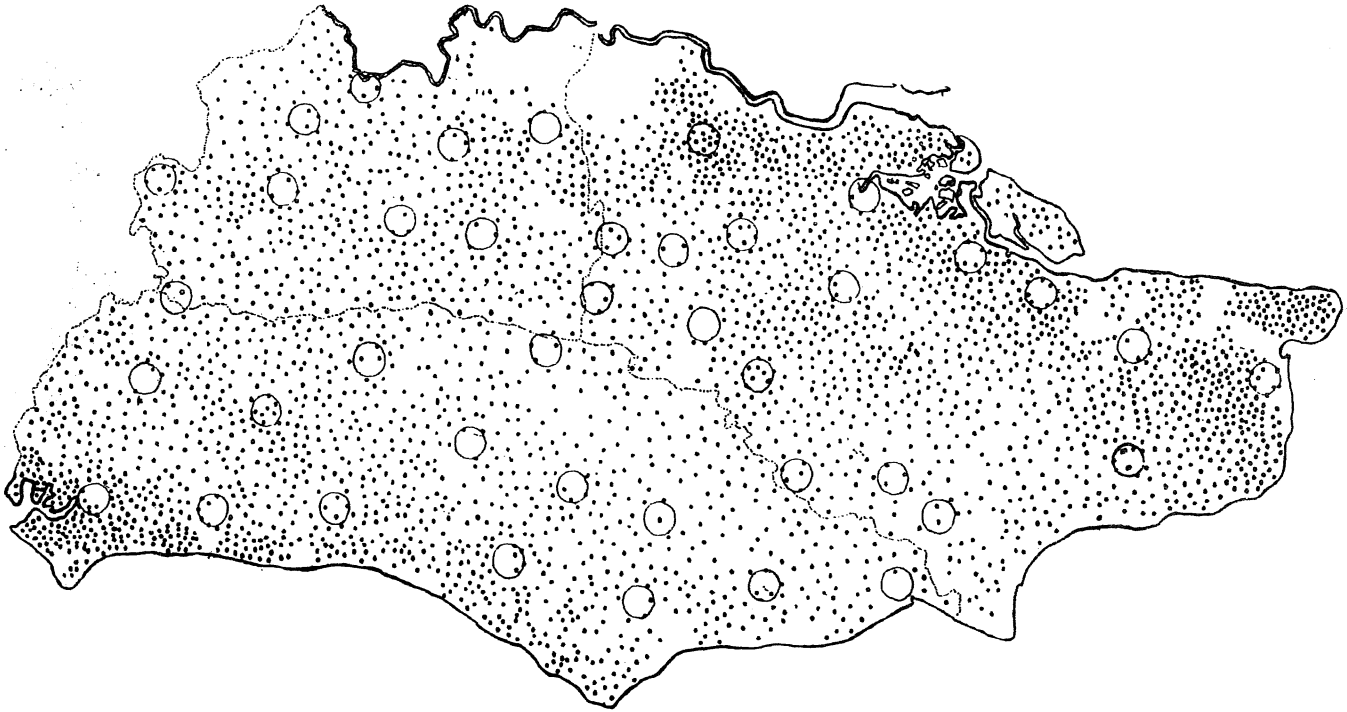

FIG. 45.—MAP SHOWING DISTRIBUTION OF WHEAT.
Each dot represents 40 acres.

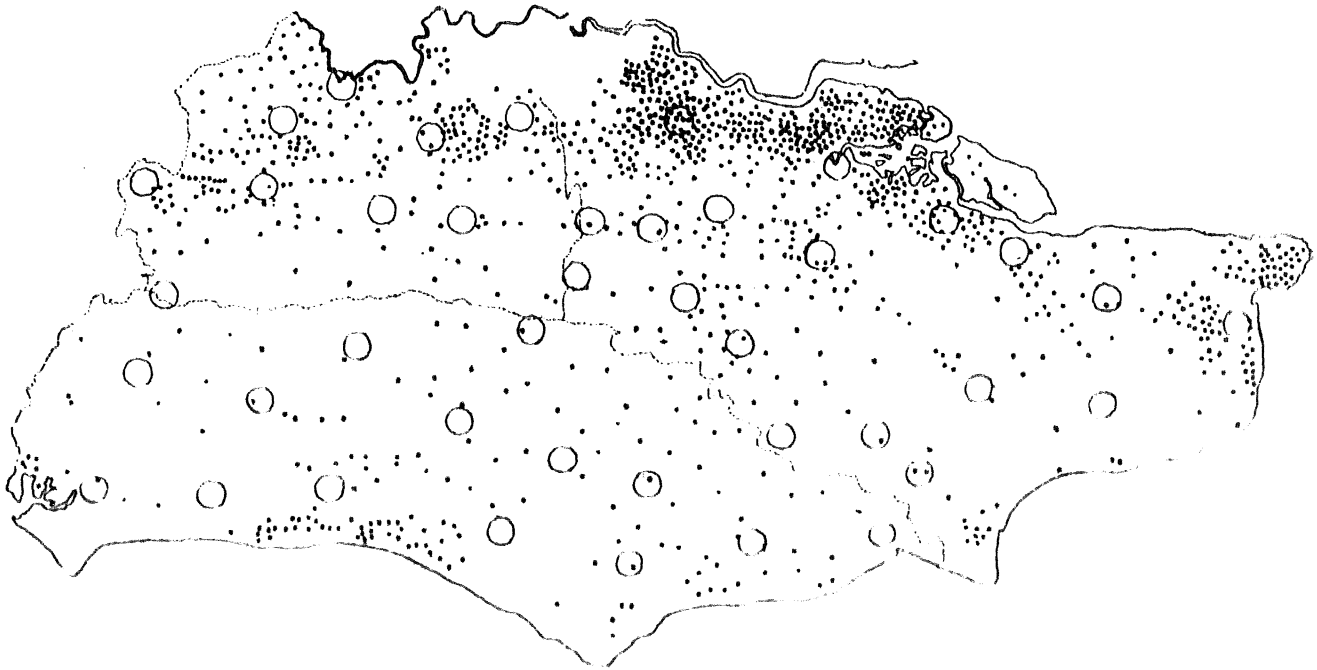

FIG. 46.—MAP SHOWING DISTRIBUTION OF POTATOES.
Each dot represents 20 acres.

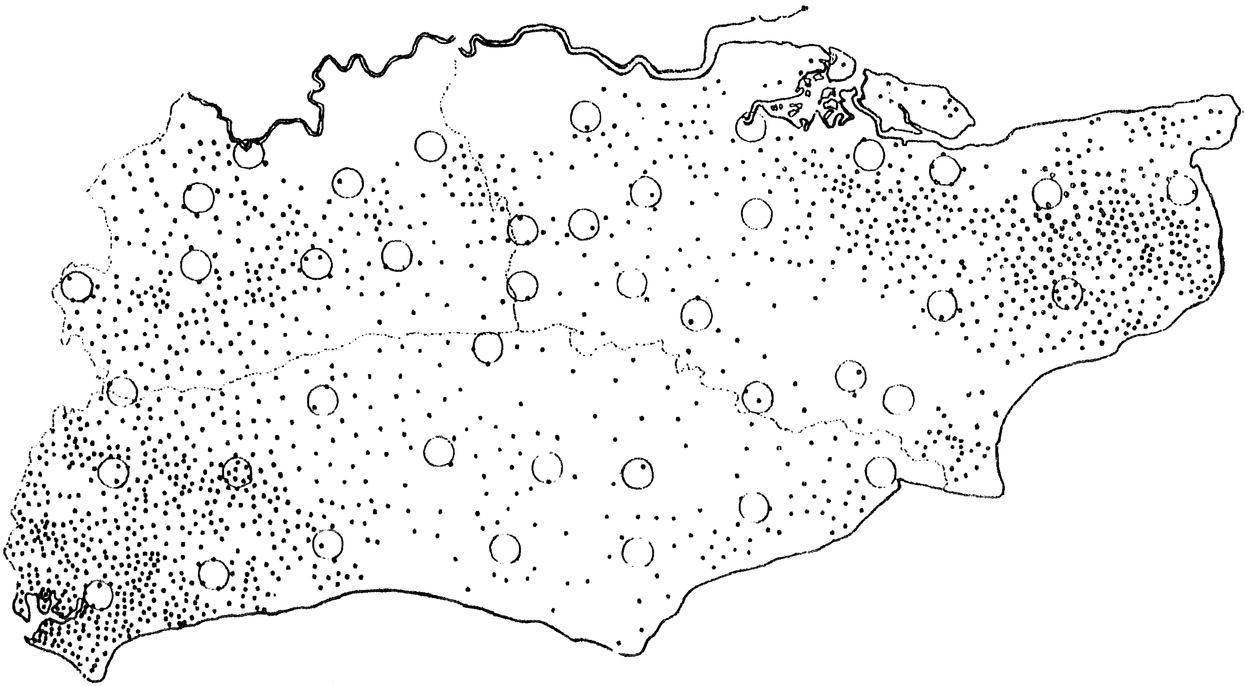

FIG. 47.—MAP SHOWING DISTRIBUTION OF TURNIPS.
Each dot represents 40 acres.

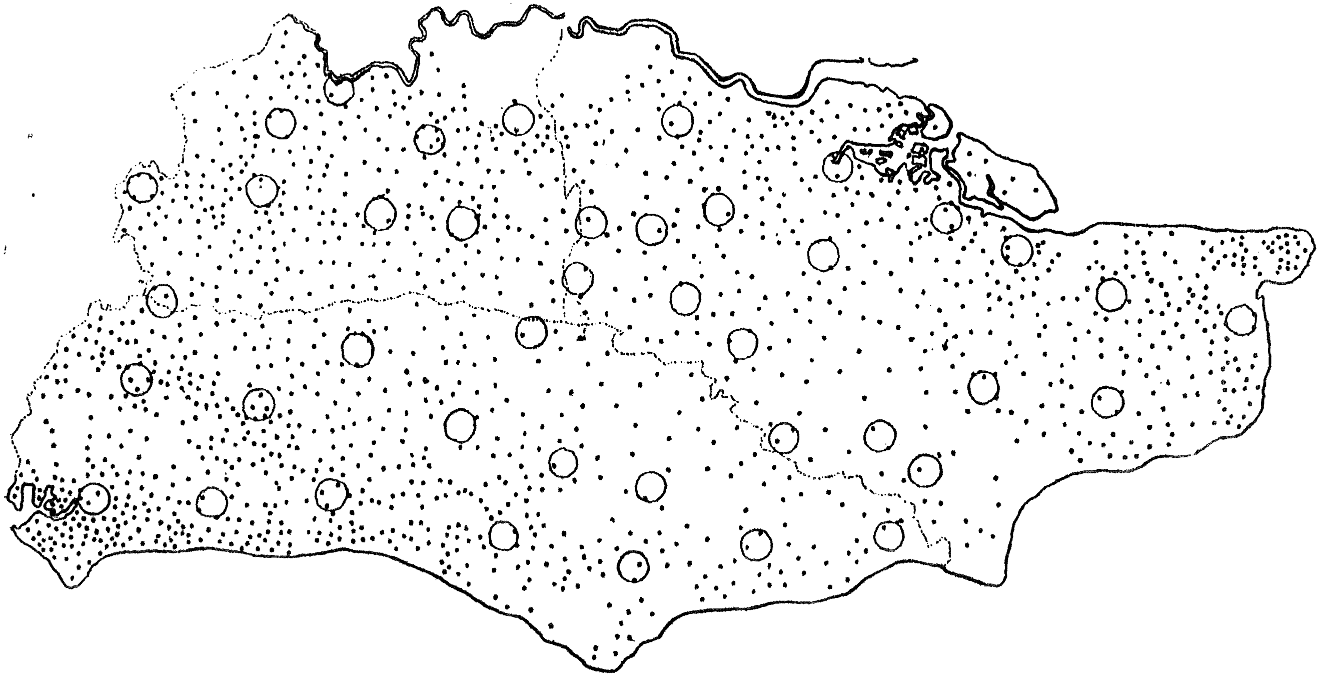

Fig. 48.—Map showing Distribution of Mangolds.

Each dot represents 25 acres.

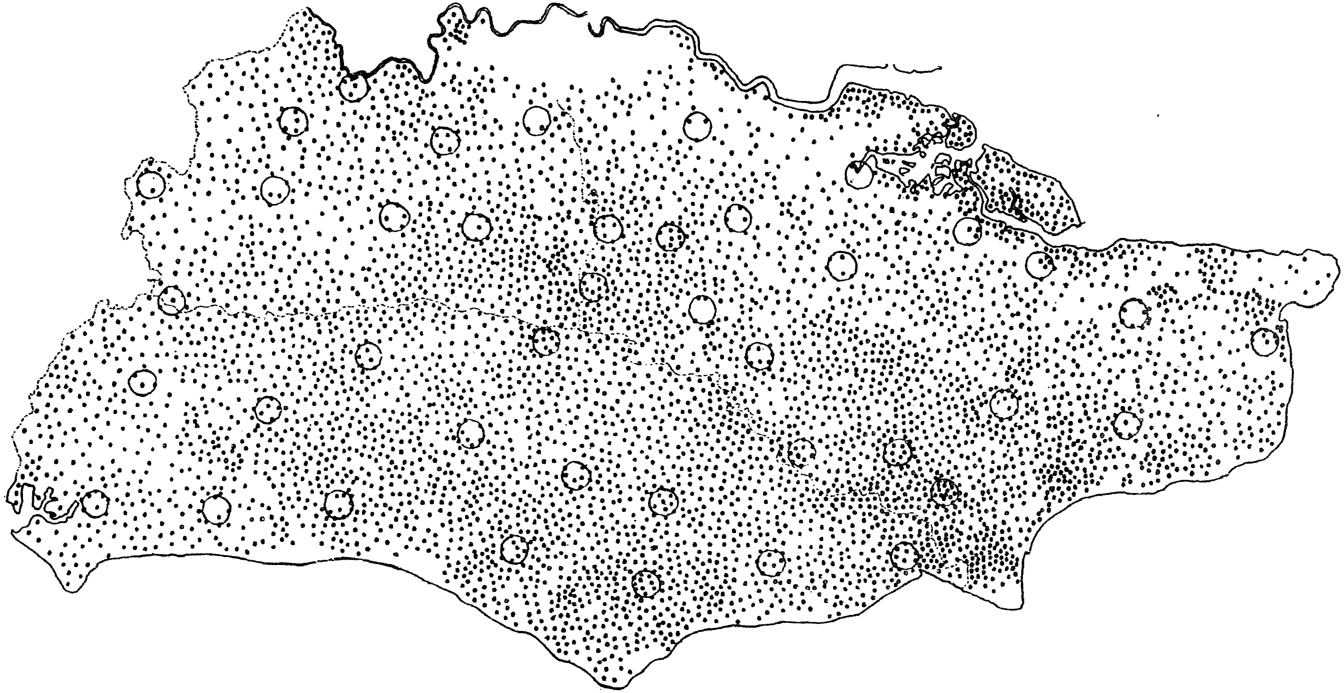

FIG. 49.—MAP SHOWING DISTRIBUTION OF GRASS.
Each dot represents 200 acres.

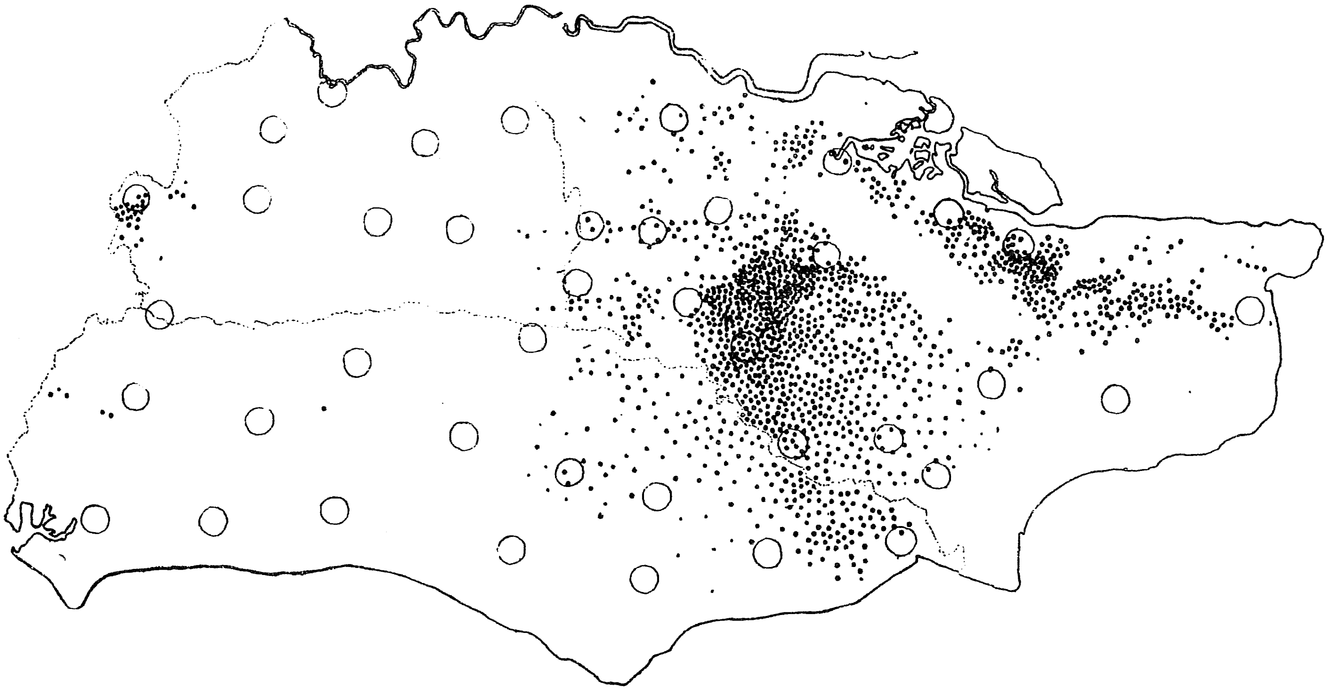

FIG. 50.—MAP SHOWING DISTRIBUTION OF HOPS.
Each dot represents 25 acres.

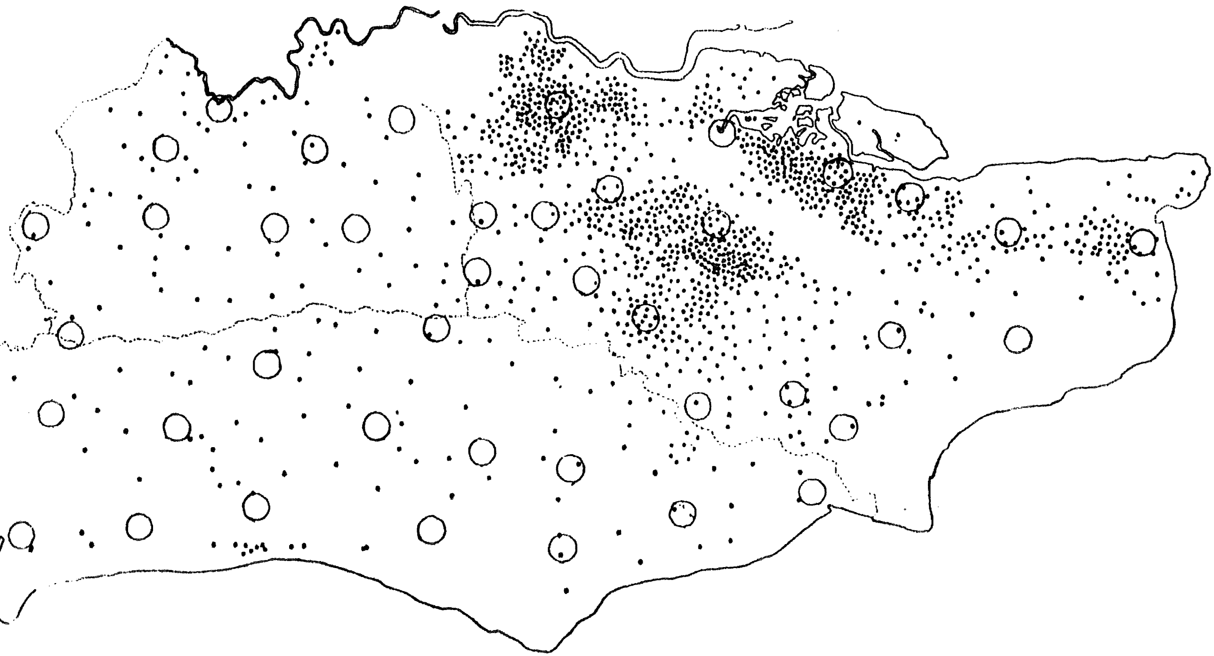

FIG. 51.—MAP SHOWING DISTRIBUTION OF FRUIT.

Each dot represents 50 acres.

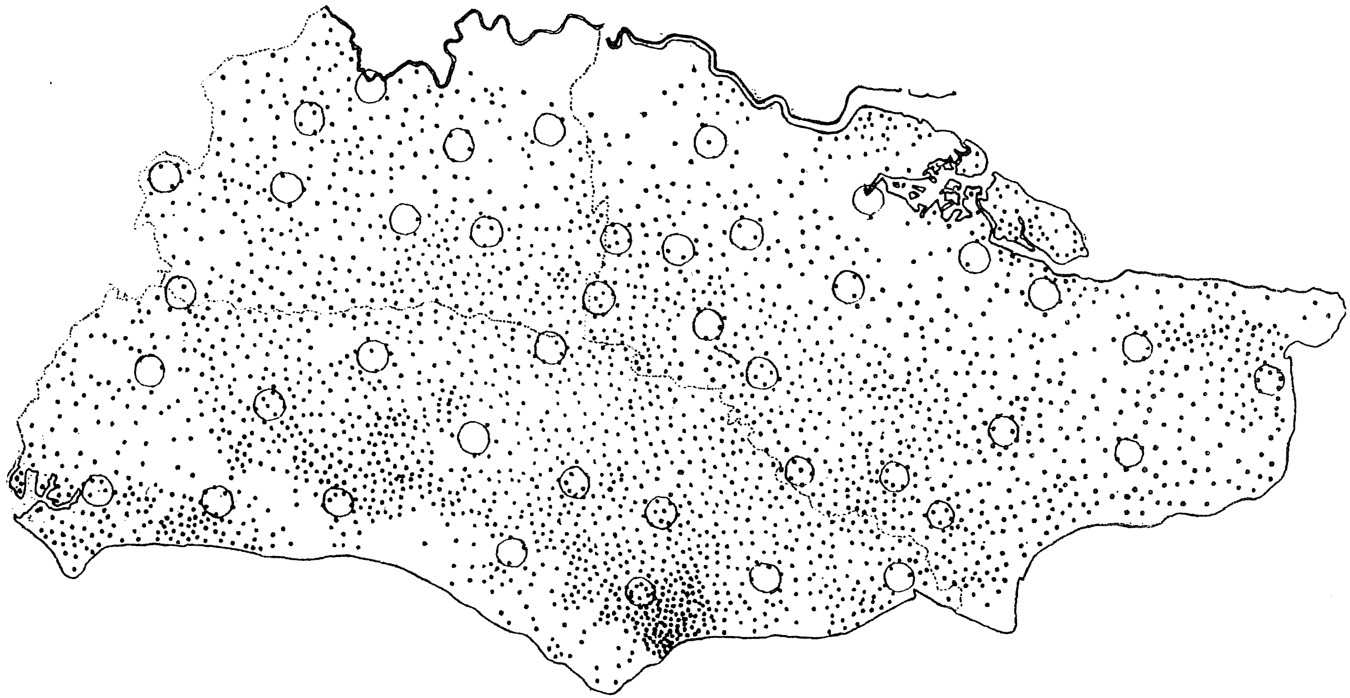

FIG. 52.—MAP SHOWING DISTRIBUTION OF CATTLE OTHER THAN MILCH COWS.
Each dot represents 50 animals.

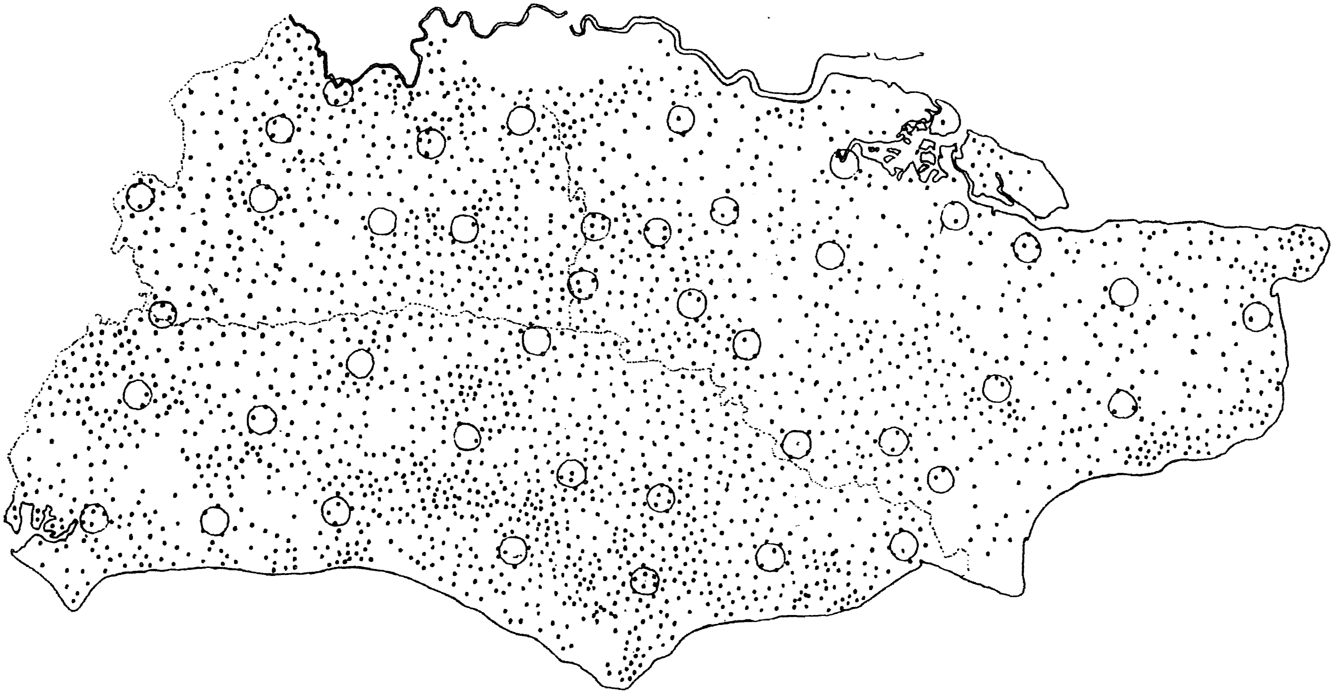

FIG. 53.—MAP SHOWING DISTRIBUTION OF DAIRY COWS.

Each dot represents 50 cows.

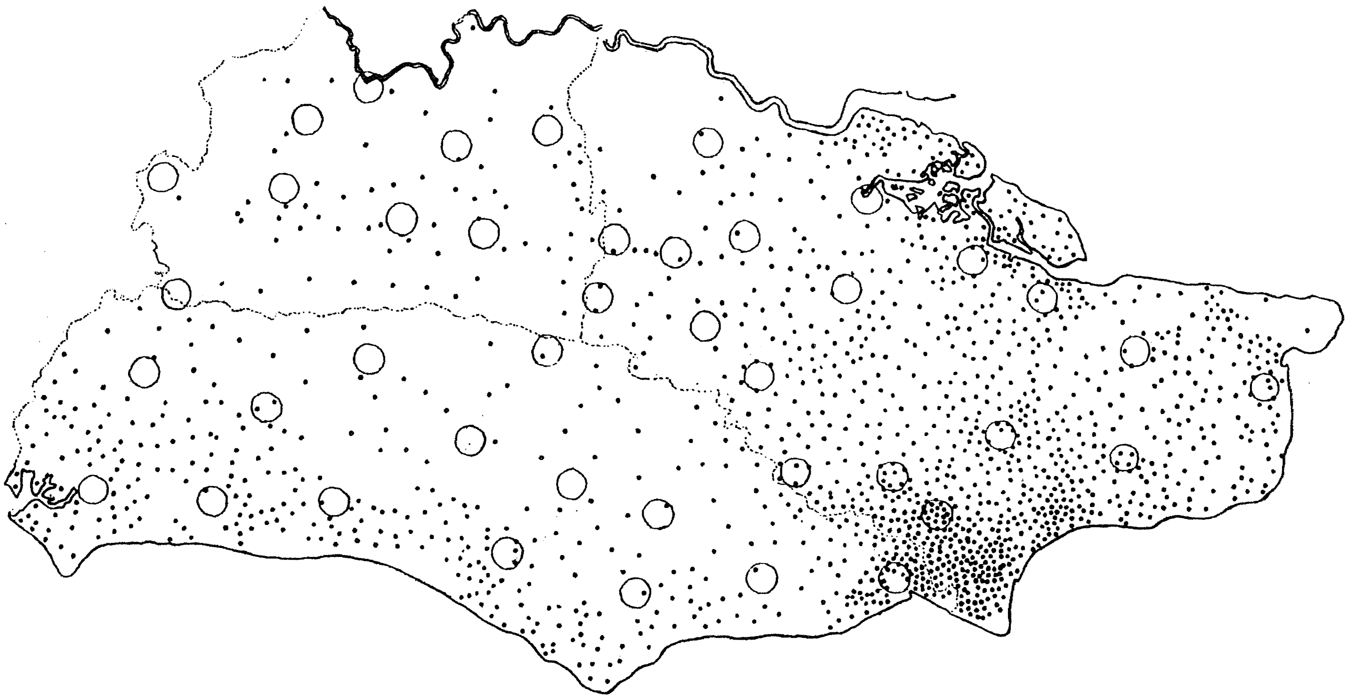

FIG. 54.—MAP SHOWING DISTRIBUTION OF SHEEP IN SUMMER.

Each dot represents 1000 *animals.*

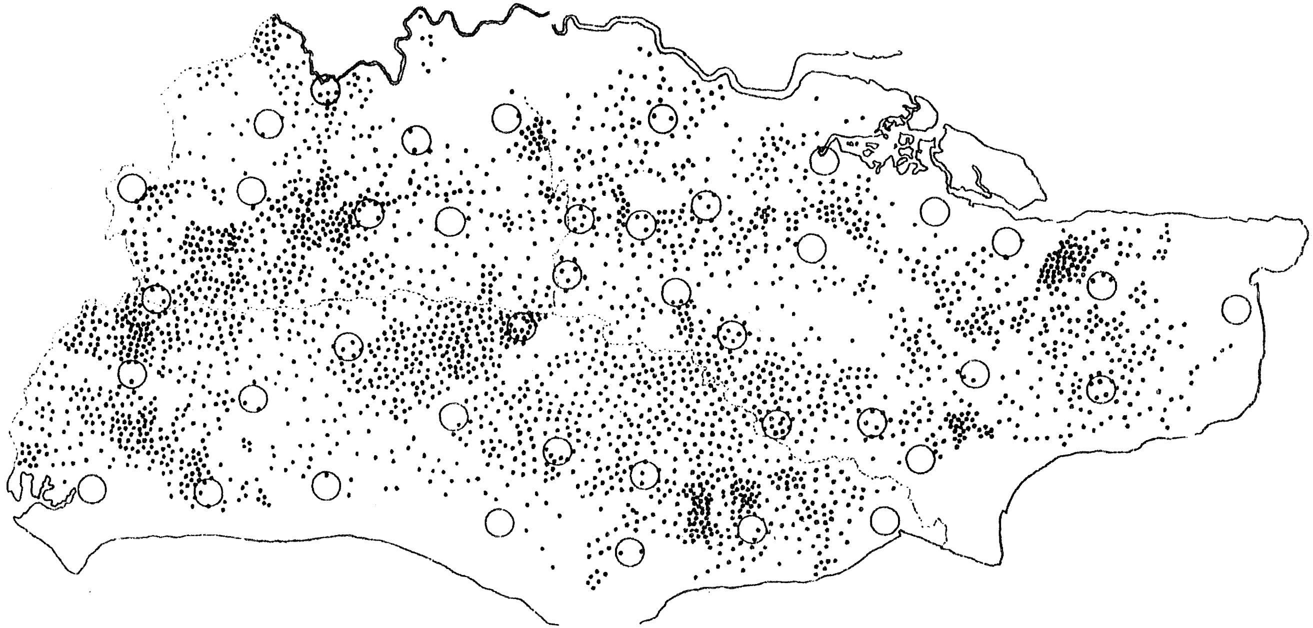

FIG. 55.—MAP SHOWING DISTRIBUTION OF WOODLAND.

Each dot represents 200 acres.